

PROJECT MANUAL

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MOODY•NOLAN

300 SPRUCE STREET, SUITE 300
COLUMBUS, OHIO 43215
614-461-4664

EDGE GROUP

LANDSCAPE ARCHITECTS
330 WEST SPRING STREET
COLUMBUS, OHIO 43215

MOODY ENGINEERING

CIVIL ENGINEERS
300 SPRUCE STREET, SUITE 300
COLUMBUS, OHIO 43215

JEZERINAC GEERS & ASSOCIATES

STRUCTURAL ENGINEERS
5640 FRANTZ ROAD
DUBLIN, OHIO 43017

AEC ENGINEERING

MEP ENGINEERS
1405 DUBLIN ROAD
COLUMBUS, OHIO 43215

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SECTION 21 05 17

SLEEVES AND SLEEVE SEALS FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- 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.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Advance Products & Systems, GPT, Metraflex, Pipeline Seal and Insulator.
- 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.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls 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 sleeve-seal system.

- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "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 078413 "Penetration Firestopping."

3.2 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.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls and Concrete Slab on Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

END OF SECTION 21 05 17

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SECTION 21 05 18

ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- D. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- E. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed or exposed-rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with inside diameter closely fitting around outside diameter of piping and piping insulation and with outside diameter completely covering opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Uninsulated Piping: One-piece steel or split-plate steel.
 - c. Insulated Piping: One-piece stamped steel or split-plate stamped steel.
 - 2. Escutcheons for Existing Piping:
 - a. Uninsulated Piping: Split-plate, stamped steel.
 - b. Insulated Piping: Split-plate, stamped steel.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with inside diameter closely fitting around piping and piping insulation and with outside diameter completely covering opening.
 - 1. New Piping: Split floor plate.
 - 2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 21 05 18

SECTION 21 05 23

GENERAL-DUTY VALVES FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Combination balancing and shutoff valves.
5. Gate valves.
6. Globe valves.
7. Chainwheels.

1.2 DEFINITIONS

- A. CWP:** Cold working pressure.
- B. EPDM:** Ethylene propylene copolymer rubber.
- C. NPS:** Nominal Pipe Size
- D. OS&Y:** Outside screw and yoke.
- E. SWP:** Steam working pressure.

1.3 SUBMITTALS

- A. Product Data:** For each type of valve indicated, include: Body, seating and trim materials; valve design; pressure and temperature classifications; end connections, arrangements; dimensions and required clearances. Submit pressure drop curves for no-slam check valves. Include a list indicating valve type and its piping system application. Include rated capacities; shipping and operating weights and furnished specialties and accessories.
- B. Contract Closeout Information:**
1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
 2. Operating and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
 - 1. Grooved end valves shall be of the same manufacturer as adjoining couplings.
- 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.
 - 4. ASME Boiler Code Specifications for Boiler Room valves.
- C. ASTM Compliance:
 - 1. ASTM B62 for 125 psi and 150 psi saturated steam rated valve pressure containing parts.
 - 2. ASTM B61 for 200 psi and 300 psi valves with metallic seats.
- D. Factory test all valve bodies, shells and seats per MSS requirements at a minimum.
- E. Iron Body Valves
 - 1. Pressure-Containing Parts: ASTM A126, Grade B.
 - 2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
 - 3. Design, Workmanship, Materials, Testing: MSS SP-70, 71, 85.
- F. Butterfly Valves
 - 1. Face-to-Face and End-to-End Dimensions: MSS SP-67.
- G. Valve Stems: ASTM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.
- H. Valve Bypass and Drain Connections: MSS SP-45.
- I. Pressure casting shall be free of impregnating materials, no welding of iron allowed.
- J. Manufacturer's name or trademark and working pressure stamped or cast into body.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooved ends, and weld ends.
 - 3. Set gate and globe valves closed to prevent rattling.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.

- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
- B. Ball, Butterfly, Check, and Globe Valves:
 - 1. Milwaukee, Hammond, Crane, NIBCO, DeZurik, Watts, Tyco, Mueller or Victaulic.
- C. Combination Balancing and Shutoff Valves:
 - 1. Armstrong, Bell & Gossett, Griswold, Taco, IMI Hydronic Engineering or Victaulic.
- D. Gate, Check, and Globe Valves:
 - 1. Milwaukee, Hammond, Crane or Flowserve.

2.2 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. Valves shall be rated for pressures and temperatures no less than 20% over that of the piping system in which they are installed. Account for piping system pressure tests when selecting component ratings.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Hand lever: For quarter-turn valves NPS 6 and smaller.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Threaded: With threads according to ASME B1.20.1.

F. Combination Balancing and Shutoff Valves:

1. Install where shown on Drawings. Valves shall be designed and used only for balancing, not shutoff.
2. Provide a means for connecting to a portable differential pressure meter for readout. A portable pressure gauge, hoses and flow curves shall be provided in a portable test kit.
3. On sizes 2-1/2" and larger, valve size, capacity and operating pressure must comply with ASME Boiler Pressure Vessel Code: Section IV.
4. Refer to manufacturer's recommendations for upstream and downstream straight piping lengths.
5. Provide an additional "separate" shutoff valve upstream of combination valves for system/component shutoff.

G. Coil Piping Packages / Coil Hook Ups:

1. Contractor has the option to use factory assembled valve packages in lieu of individual valves and ports as shown on the Drawings at any terminal unit connections.
2. Shall only be provided on pipes 1-1/2" and smaller.
3. All components shall be rated for 250 psig working pressure and shall be globe-type or full-port (full-bore) design.
4. The order and arrangement of components shall be consistent with the Drawings.
5. Each individual component shall meet the specification requirements for components of a field-assembled system.

2.3 BALL VALVES

A. Bronze Ball Valves:

1. Description:
 - a. Standard: MSS SP-110.
 - b. ANSI Class: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.

- f. Ends: Threaded or Soldered for copper piping.
- g. Seats: Reinforced PTFE.
- h. Stem: Stainless steel.
- i. Ball: Chrome plate ball, vented.
- j. Port: Full.
- k. Operator: Hand Lever.

2.4 BUTTERFLY VALVES

A. Single-Flange, Butterfly Valves:

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.
- h. Operator: 10 Position Hand Lever for less than 6", Gear Actuator for 6" and larger.
- i. Other: Valves and Seats shall be rated for 150 psi shutoff during dead-end service, without downstream piping or flange.

B. Grooved-End, Butterfly Valves (Cast Brass):

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 300 psig.
- c. Body Material: Cast brass.
- d. Stem: Two-piece stainless steel.
 - 1) Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
- e. Disc: Aluminum-bronze.
- f. Seal: Pressure-responsive EPDM.
- g. Copper-tube dimensioned grooved ends.

C. Grooved-End, Butterfly Valves (Iron):

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 300 psig (24" and smaller).
- c. Body Material: Coated, ductile iron.
- d. Stem: Two-piece stainless steel.
 - 1) Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.

- e. Disc: Coated, ductile iron.
- f. Seal: EPDM.
 - 1) Pressure responsive in sizes 12" and smaller.

2.5 CHECK VALVES

A. Lift Check Valves:

1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Design: Vertical flow.
- e. Body Material: ASTM B 61 or ASTM B 62, bronze.
- f. Ends: Threaded or Soldered for copper piping.
- g. Disc: Reinforced PTFE.
- h. Cap: Threaded.

B. Globe Body Silent Check Valves:

1. Description:

- a. ANSI Class: 125
- b. Body Material: ASTM A 48, Class 35, cast iron.
- c. Disc Material: Cast Iron with Bronze Face Rings
- d. Ends: Flanged or Wafer.
- e. Trim: Bronze.
- f. Spring Material: Stainless Steel T304 (ASTM A 276).

C. Bronze Swing Check Valves:

1. Description:

- a. Standard: MSS SP-80, Type 3.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Design: Horizontal flow.
- e. Body Material: ASTM B 62, bronze.
- f. Ends: Threaded or Soldered for copper piping.
- g. Disc: Reinforced PTFE.
- h. Cap: Threaded.

D. Iron Swing Check Valves:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.

- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A 126, cast iron.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.
- i. Cap: Bolted.

E. Cast Steel Swing Check Valves:

1. Description:

- a. ANSI Class: 300
- b. Body Material: ASTM A 216, cast steel.
- c. Disc Material (2" to 4"): Steel (ASTM A 217, Gr. CA-15).
- d. Disc Material (6" to 12"): Steel with Hard Faced (ASTM A 216, Gr. WCB).
- e. Ends: Flanged.
- f. Seat Ring Material: Stellite hard facing over plain carbon steel.
- g. Bonnet: Bolted.

F. Grooved-End, Spring-Assisted Swing Check Valves

1. Description:

- a. CWP Rating:
 - 1) 12" and smaller: 300 psig.
 - 2) 14" to 24": 230 psig.
- b. Body Material: ASTM A 536, ductile iron.
- c. Seal: EPDM.
- d. Disc: Spring-operated, ductile iron or stainless steel.
- e. Installation: Vertical or horizontal.

2.6 COMBINATION BALANCING AND SHUTOFF VALVES

A. Calibrated Ball Type or Venturi Combination Balancing and Shutoff Valves:

1. Description:

- a. CWP Rating: 125 psig.
- b. Body Material: Brass or Bronze (ASTM B 62)
- c. Ends: Flanged, Threaded or Soldered for copper piping.
- d. Seat Material: Double-seated Teflon.
- e. Ball Material: Stainless Steel.
- f. Stem Material: Brass/Bronze sealed with blow-out proof EPDM O-Ring.
- g. Operator: Lever with memory stop.

2.7 GATE VALVES

A. Bronze Gate Valves:

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. ANSI Class: 150
- c. CWP Rating: 300 psig.
- d. Body Material: ASTM B 62, cast bronze.
- e. Ends: Threaded.
- f. Stem: Non-Rising.
- g. Disc: Solid wedge; bronze.
- h. Packing: Asbestos free.
- i. Bonnet: Union
- j. Operator: Hand Wheel-Malleable iron.

B. Iron Gate Valves:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Material: ASTM A 126, cast iron.
- e. Ends: Flanged.
- f. Wedge and Seat Rings Material: Cast bronze.
- g. Disc: Solid wedge-Cast iron.
- h. Packing and Gasket: Asbestos free.
- i. Bonnet: Bolted
- j. Stem: O.S. & Y.
- k. Operator: Hand Wheel-Cast iron.

C. Forged Carbon Steel Gate Valves:

1. Description:

- a. ANSI Class: 300 or 600
- b. Body Material: ASTM A 105, forged carbon steel.
- c. Ends: Flanged or weld.
- d. Seat Ring Material: Hard faced stainless steel (Type 410).
- e. Disc: Solid wedge-Stainless steel (Type 410).
- f. Bonnet: Bolted
- g. Packing and Gasket: Asbestos free.
- h. Stem: O.S. & Y.
- i. Operator: Hand Wheel-Malleable iron.

D. Cast Steel Gate Valves:

1. Description:

- a. ANSI Class: 300
- b. Body Material: ASTM A 216, cast steel.
- c. Ends: Flanged.
- d. Seat Ring Material: Stellite hard facing over plain carbon steel.

- e. Disc: Stainless steel (ASTM A 217).
- f. Bonnet: Bolted.
- g. Stem: O.S. & Y.
- h. Operator: Hand Wheel-Malleable iron.

2.8 GLOBE VALVES

A. Bronze Globe Valves:

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. ANSI Class: 150
- c. Body Material: ASTM B 62, bronze.
- d. Ends: Threaded or Flanged.
- e. Stem: Rising.
- f. Disc: 420 Stainless Steel.
- g. Seat Ring Material: 420 Stainless Steel.
- h. Bonnet: Union.
- i. Operator: Hand Wheel-Malleable iron.

B. Iron Globe Valves:

1. Description:

- a. Standard: MSS SP-85, Type I.
- b. ANSI Class: 125
- c. Body Material: ASTM A 126, cast iron.
- d. Disc Material: ASTM B 62; Bronze.
- e. Seat Ring Material: ASTM B 62; Bronze.
- f. Ends: Flanged.
- g. Bonnet: Bolted.
- h. Stem: O.S. & Y.
- i. Operator: Hand Wheel-Cast or malleable iron.

C. Forged Steel Globe Valves:

1. Description:

- a. ANSI Class: 300 or 600
- b. Body Material: ASTM A 105, forged steel.
- c. Disc Material: Loose-Stainless Steel (Type 410).
- d. Seat Material (Class 300): Integral Hard Faced.
- e. Seat Material (Class 600): Renewable Stainless Steel (Type 410)
- f. Ends: Flanged or Butt Weld.
- g. Bonnet: Bolted.
- h. Stem: O.S. & Y.
- i. Operator: Hand Wheel-Malleable iron.

D. Cast Steel Globe Valves:

1. Description:
 - a. ANSI Class: 300
 - b. Body Material: ASTM A 216, cast steel.
 - c. Disc Material: Stainless steel.
 - d. Seat Ring Material: Stellite hard facing over plain carbon steel.
 - e. Ends: Flanged.
 - f. Bonnet: Bolted.
 - g. Stem: O.S. & Y.
 - h. Operator: Hand Wheel, Hand Lever or Gear Actuator for 6" and larger.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.
- F. Examine grooved ends for form and cleanliness. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.

3.2 VALVE INSTALLATION

- A. Install valves at locations shown on the Drawings, per the Specifications and in accordance with manufacturer's written instructions.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings (the couplings shall serve as disconnect points if required).
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with handwheel and stem at or above center of pipe.

- F. Install valves in position to allow full stem movement.
- G. Install chainwheels on operators for all valves located with the lowest portion of its handwheel or lever at 10' or more above finished floor. Extend chains to 5' above finished floor.
- H. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.
- I. Install Combination Balancing and Shutoff Valves at each branch connection to return main.
- J. Install Start/Stop flow valve for isolation at each branch connection to supply main.
- K. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- L. All check valves should be installed in a location that has smooth and laminar flow conditions.
- M. For swing type check valves, locate valve a minimum of 10 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 5 pipe diameters downstream of valve.
- N. For silent type check valves, locate valve a minimum of 4 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 3 pipe diameters downstream of valve.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If 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.

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SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE PROTECTION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Fiberglass strut systems.
5. Thermal-hanger shield inserts.
6. Fastener systems.
7. Equipment supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 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 fire protection 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.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.
2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - a. Trapeze pipe hangers.
 - b. Equipment supports.

B. Informational Submittals:

1. Welding certificates.

C. Closeout Submittals:

1. Operation and Maintenance Data

1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. SMACNA.
- D. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.
- E. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, so as to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. B-line Systems, Inc; a division of Cooper Industries.
 2. Carpenter & Paterson, Inc.
 3. ERICO/Michigan Hanger Co.

4. Globe Pipe Hanger Products, Inc.
5. Grinnell Corp.
6. National Pipe Hanger Corporation.
7. PHD Manufacturing, Inc.

B. 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 or stainless steel.

C. Saddles

1. Material Galvanized Steel, 180-degree shape, each saddle marked with insulation O.D. Standard manufacturers gauge per insulated pipe size.

D. 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.

E. 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 or stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. Carpenter & Paterson, Inc.
 2. ERICO International Corporation.
 3. National Pipe Hanger Corporation.
 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig, or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- C. 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.

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. 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 attachments, 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 that 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 to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:

- a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers, fiberglass pipe hangers, fiberglass strut systems, and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. 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.
 5. 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.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 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.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. 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 allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 21 05 29

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SECTION 21 05 53

IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.
2. Samples: For color, letter style, and graphic representation required for each identification material and device.
3. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
4. Valve numbering scheme.

B. Closeout Submittal:

1. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger

lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-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-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-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-quarters the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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: Size letters according to ASME A13.1 for piping.

2.4 STENCILS

- A. Stencils for Piping:
 - 1. Lettering Size: Size letters according to ASME A13.1 for piping.
 - 2. Stencil Material: Fiberboard or metal.
 - 3. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 4. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
- B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:
 - 1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
 - 2. Stencil Material: Fiberboard or metal.
 - 3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.

4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain, or beaded chain, or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- 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.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, 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.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve or control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.
 - 2. Fire Protection Piping:
 - a. Background: Red.
 - b. Letter Colors: White.

3.5 VALVE-TAG INSTALLATION

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

and lawn-watering hose connections, and 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: 1-1/2 inches, round.
2. Valve-Tag Colors: Natural.
3. Letter Colors: Black.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 21 05 53

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Sprinklers.
 - 4. Alarm devices.
 - 5. Backflow Preventer.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gages.

1.2 DEFINITIONS

- A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 250 psig.
- B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.3 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
- B. Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system, in same area as sprinklers, opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

1.4 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

- B. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.
- C. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Available fire-hydrant flow test records indicate the following conditions:
 - a. Date: 7/5/2017.
 - b. Time: 1:40 PM
 - c. Performed by: City of Columbus Water Division
 - d. Location of Residual Fire Hydrant R: 2S of Cottonwood Dr on Karl Rd.
 - e. Location of Flow Fire Hydrant F: 3S of Cottonwood Dr on Karl Rd
 - f. Static Pressure at Residual Fire Hydrant R: 54.4 psig.
 - g. Measured Flow at Flow Fire Hydrant F: 580 gpm.
 - h. Residual Pressure at Residual Fire Hydrant R: 52.9 psig.
 - 2. Contractor to perform a flow test and utilize results of flow test for system design.
- D. Sprinkler system design shall be reviewed and approved by the design Fire Protection Engineer before being submitted for approval by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Automobile Parking Areas: Ordinary Hazard, Group 1.
 - b. Building Service Areas: Ordinary Hazard, Group 1.
 - c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - d. Elevator Machine Rooms: Ordinary Hazard, Group 1.
 - e. General Storage Areas: Ordinary Hazard, Group 1.
 - f. Laundries: Ordinary Hazard, Group 1.
 - g. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - h. Office and Public Areas: Light Hazard.
 - i. Restaurant Service Areas: Ordinary Hazard, Group 1.
 - 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft.
 - 4. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft.
 - b. Storage Areas: 130 sq. ft.
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
 - 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

- a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
- E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work. Also include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Domestic water piping.
 - 2. Compressed air piping.
 - 3. HVAC hydronic piping.
 - 4. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- E. Qualification Data: For qualified Installer and NICET designer.
- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, for approval by the design fire protection engineer before sending for approval by authorities having jurisdiction, including hydraulic calculations if applicable.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems. Base calculations on results of fire-hydrant flow test. Design shall be signed by a NICET Level III or IV and for review by the design FPE.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Architect and/or Owner no fewer than five days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Architect's and/or Owner's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- C. Galvanized and Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
- E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: 250 psig minimum.
 - 2. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 CPVC PIPE AND FITTINGS

- A. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig rated pressure at 150 deg F, with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.
- B. CPVC Fittings: UL listed or FM approved, for 175-psig rated pressure at 150 deg F, socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.
 - 1. NPS 3/4 to NPS 1-1/2: ASTM F 438 and UL 1821, Schedule 40, socket type.
 - 2. NPS 2 to NPS 3: ASTM F 439 and UL 1821, Schedule 80, socket type.

3. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
4. Flanges: CPVC, one or two pieces.

2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
 1. Use solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Use adhesive primer that has a VOC content of 650 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Coordinate submittal requirements of the VOC information with the LEED application requirements.
- D. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 COVER SYSTEM FOR SPRINKLER PIPING

- A. Description: System of support brackets and covers made to protect sprinkler piping.
- B. Brackets: Glass-reinforced nylon.
- C. Covers: Extruded PVC sections of length, shape, and size required for size and routing of CPVC piping.

2.6 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 1. Valves shall be UL listed or FM approved.
 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

3. Minimum Pressure Rating for High-Pressure Piping: 250 psig.

B. Ball Valves:

1. Standard: UL 1091 except with ball instead of disc.
2. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
3. Valves NPS 2: Bronze body with threaded ends or ductile-iron body with grooved ends.

C. Check Valves:

1. Standard: UL 312.
2. Pressure Rating: 250 psig minimum.
3. Type: Swing check.
4. Body Material: Cast iron.
5. End Connections: Flanged or grooved.

D. Bronze OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 175 psig.
3. Body Material: Bronze.
4. End Connections: Threaded.

E. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

F. Indicating-Type Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
4. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
5. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

2.7 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
 - b. High-Pressure Piping Specialty Valves: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Deluge Valves:

1. Standard: UL 260.
2. Design: Hydraulically operated, differential-pressure type.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
4. Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.

D. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.8 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig minimum.

3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection, Test, and Drain Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum 300 psig.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250 psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175 psig minimum.

4. Size: Same as connected piping, for sprinkler.

2.9 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum.
4. Sprinklers shall be quick-response type heads. Sprinklers with "O" rings are prohibited.

B. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

C. Open Sprinklers with Heat-Responsive Element Removed: UL 199.

1. Characteristics:
 - a. Nominal 1/2-inch Orifice: With Discharge Coefficient K between 5.3 and 5.8.
 - b. Nominal 17/32-inch Orifice: With Discharge Coefficient K between 7.4 and 8.2.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

E. Special Coatings:

1. Wax.
2. Lead.
3. Corrosion-resistant paint.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

G. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

1. Standard: UL 753.
2. Type: Mechanically operated, with Pelton wheel.
3. Alarm Gong: Cast aluminum with red-enamel factory finish.
4. Size: diameter.
5. Components: Shaft length, bearings, and sleeve to suit wall construction.
6. Inlet: .
7. Outlet: drain connection.

C. Electrically Operated Alarm Bell:

1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.
3. Size: 8-inch minimum- diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: .
6. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.11 BACKFLOW PREVENTERS

A. Double-Check, Detector-Assembly Backflow Preventers:

1. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
2. Operation: Continuous-pressure applications.
3. Pressure Loss: maximum, through middle one-third of flow range.
4. Size: As required per contract documents.
5. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
6. End Connections: Flanged.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
 - a. Valves: UL 262 and FM Global's "Approval Guide" listing; OS&Y gate type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

B. Backflow Preventer Test Kits:

1. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.12 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

3. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.13 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- C. Pressure Gage Range: 0 to 250 psig minimum. Provide pressure
- D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.

3.4 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

- P. Install sleeve seals for piping penetrations of exterior concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.5 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- K. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

- L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- M. Plastic-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. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.6 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

3.7 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
 - 3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.8 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.9 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Coordinate with fire-pump tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.12 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2, shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, black-steel pipe with cut- or roll- grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 3. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Concealed.
 3. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
 4. Special Applications: Extended-coverage and flow-control where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Rotor: Random-wound, squirrel cage.
- E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating.
- G. Insulation: Class F.
- H. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Grounding: Maintenance free, conductive micro-fiber shaft-grounding ring with a minimum of two rows of circumferential micro fibers to discharge shaft voltages away from the bearings to ground.
 - a. Motors 100 HP or Less: One shaft grounding ring installed either on the drive end or non-drive end.
 - b. Motors More Than 100 HP: Insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor.

- c. All Motors: Bonded from motor foot to system ground with high-frequency ground strap of flat braided, tinned copper with terminations to accommodate motor foot and system ground connections.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Motor: Brushless permanent magnet DC motor.
- B. Control: Integral control module to convert AC power to DC power and to generate three-phase signal to direct motor speed. Motor speed adjustment through 0-10 V DC input.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 05 13

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SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- 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.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Advance Products & Systems, GPT, Metraflex, Pipeline Seal and Insulator.
- 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.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls 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 sleeve-seal system.

- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "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 078413 "Penetration Firestopping."

3.2 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.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls and Concrete Slab on Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

END OF SECTION 22 05 17

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SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- D. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- E. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed or exposed-rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with inside diameter closely fitting around outside diameter of piping and piping insulation and with outside diameter completely covering opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Uninsulated Piping: One-piece steel or split-plate steel.
 - c. Insulated Piping: One-piece stamped steel or split-plate stamped steel.
 - 2. Escutcheons for Existing Piping:
 - a. Uninsulated Piping: Split-plate, stamped steel.
 - b. Insulated Piping: Split-plate, stamped steel.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with inside diameter closely fitting around piping and piping insulation and with outside diameter completely covering opening.
 - 1. New Piping: Split floor plate.
 - 2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 22 05 18

SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Filled-system thermometers.
 - 3. Liquid-in-glass thermometers.
 - 4. Thermowells.
 - 5. Dial-type pressure gages.
 - 6. Gage attachments.
 - 7. Test plugs.
 - 8. Test-plug kits.
 - 9. Sight flow indicators.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- 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. [Ashcroft Inc.](#)
 - 2. [Ernst Flow Industries.](#)

3. [Marsh Bellofram.](#)
4. [Miljoco Corporation.](#)
5. [Nanmac Corporation.](#)
6. [Noshok.](#)
7. [Palmer Wahl Instrumentation Group.](#)
8. [REOTEMP Instrument Corporation.](#)
9. [Tel-Tru Manufacturing Company.](#)
10. [Trerice, H. O. Co.](#)
11. [Watts Regulator Co.; a div. of Watts Water Technologies, Inc.](#)
12. [Weiss Instruments, Inc.](#)
13. [WIKA Instrument Corporation - USA.](#)
14. [Winters Instruments - U.S.](#)

- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with **5-inch** nominal diameter.
- D. Dial: Non reflective aluminum with permanently etched scale markings and scales in **deg F**.
- E. Connector Type(s): Union joint, adjustable angle rigid, back and rigid, bottom, with unified-inch screw threads.
- F. Connector Size: **1/2 inch**, with ASME B1.1 screw threads.
- G. Stem: **0.25 or 0.375 inch** in diameter; stainless steel.
- H. Window: Plain glass or plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1.5 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

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. [Ashcroft Inc.](#)
 - b. [Marsh Bellofram.](#)
 - c. [Miljoco Corporation.](#)
 - d. [Palmer Wahl Instrumentation Group.](#)
 - e. [REOTEMP Instrument Corporation.](#)
 - f. [Trerice, H. O. Co.](#)

g. Weiss Instruments, Inc.

2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel; 5-inch 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: Glass or 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 rigid, back and rigid, bottom; 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.

2.3 LIQUID-IN-GLASS THERMOMETERS

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

1. Manufacturers: Ashcroft, Terice, Weiss
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Straight unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.
9. Design for Thermowell Installation: Bare stem.
10. Connector: 3/4 inch, with ASME B1.1 screw threads.
11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 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.

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, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, 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.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Ashcroft, Terice, Weiss
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

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

2.7 TEST PLUGS

- A. Manufacturers: Terice, Weiss, Watts
- 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 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 SIGHT FLOW INDICATORS

- A. Manufacturers: Dwyer, OPW, Archon Industries
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 125 psig.
- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install test plugs in piping tees.
- K. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
 - 2. Inlets and outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
 - 4. Inlet and outlet of each remote domestic water chiller.
- L. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

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

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Direct metal case, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.
 - 4. Direct-mounted, light-activated type.
 - 5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be the following:
 - 1. Liquid-filled, bimetallic-actuated type.
 - 2. Direct mounted, metal case, vapor-actuated type.
 - 3. Industrial-style, liquid-in-glass type.
 - 4. Direct mounted, light-activated type.
 - 5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

- C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.
- B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.
- C. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be one of the following:
 - 1. Liquid-filled, direct mounted, metal case.
 - 2. Sealed, direct mounted, plastic case.
 - 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:
 - 1. Liquid-filled, direct mounted, metal case.
 - 2. Sealed, direct mounted, plastic case.
 - 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- C. Pressure gages at suction and discharge of each domestic water pump shall be the following:
 - 1. Liquid-filled, direct mounted, metal case.
 - 2. Sealed, direct mounted, plastic case.
 - 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 160 psi and 0 to 1100 kPa.
- B. Scale Range for Domestic Water Piping: 0 to 160 psi and 0 to 1100 kPa.

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SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
 - 4. Combination balancing and shutoff valves.
 - 5. Gate valves.
 - 6. Globe valves.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NPS: Nominal Pipe Size
- D. OS&Y: Outside screw and yoke.
- E. SWP: Steam working pressure.

1.3 SUBMITTALS

- A. Product Data: For each type of valve indicated, include: Body, seating and trim materials; valve design; pressure and temperature classifications; end connections, arrangements; dimensions and required clearances. Submit pressure drop curves for no-slam check valves. Include a list indicating valve type and its piping system application. Include rated capacities; shipping and operating weights and furnished specialties and accessories.
- B. Contract Closeout Information:
 - 1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
 - 2. Operating and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
 - 1. Grooved end valves shall be of the same manufacturer as adjoining couplings.
- 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.
 - 4. ASME Boiler Code Specifications for Boiler Room valves.
- C. ASTM Compliance:
 - 1. ASTM B62 for 125 psi and 150 psi saturated steam rated valve pressure containing parts.
 - 2. ASTM B61 for 200 psi and 300 psi valves with metallic seats.
- D. Factory test all valve bodies, shells and seats per MSS requirements at a minimum.
- E. Iron Body Valves
 - 1. Pressure-Containing Parts: ASTM A126, Grade B.
 - 2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
 - 3. Design, Workmanship, Materials, Testing: MSS SP-70, 71, 85.
- F. Butterfly Valves
 - 1. Face-to-Face and End-to-End Dimensions: MSS SP-67.
- G. Valve Stems: ASTM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.
- H. Valve Bypass and Drain Connections: MSS SP-45.
- I. Pressure casting shall be free of impregnating materials, no welding of iron allowed.
- J. Manufacturer's name or trademark and working pressure stamped or cast into body.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooved ends, and weld ends.
 - 3. Set gate and globe valves closed to prevent rattling.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.

- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
- B. Ball, Butterfly, Check, Gate, and Globe Valves:
 - 1. Milwaukee, Hammond, Crane, NIBCO, DeZurik, Watts, Tyco, Mueller or Victaulic.
- C. Combination Balancing and Shutoff Valves:
 - 1. Armstrong, Bell & Gossett, Griswold, Taco, IMI Hydronic Engineering or Victaulic.

2.2 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. Valves shall be rated for pressures and temperatures no less than 20% over that of the piping system in which they are installed. Account for piping system pressure tests when selecting component ratings.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Hand lever: For quarter-turn valves NPS 6 and smaller.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Threaded: With threads according to ASME B1.20.1.

F. Combination Balancing and Shutoff Valves:

1. Install where shown on Drawings. Valves shall be designed and used only for balancing, not shutoff.
2. Provide a means for connecting to a portable differential pressure meter for readout. A portable pressure gauge, hoses and flow curves shall be provided in a portable test kit.
3. On sizes 2-1/2" and larger, valve size, capacity and operating pressure must comply with ASME Boiler Pressure Vessel Code: Section IV.
4. Refer to manufacturer's recommendations for upstream and downstream straight piping lengths.
5. Provide an additional "separate" shutoff valve upstream of combination valves for system/component shutoff.

G. Coil Piping Packages / Coil Hook Ups:

1. Contractor has the option to use factory assembled valve packages in lieu of individual valves and ports as shown on the Drawings at any terminal unit connections.
2. Shall only be provided on pipes 1-1/2" and smaller.
3. All components shall be rated for 250 psig working pressure and shall be globe-type or full-port (full-bore) design.
4. The order and arrangement of components shall be consistent with the Drawings.
5. Each individual component shall meet the specification requirements for components of a field-assembled system.

2.3 BALL VALVES

A. Bronze Ball Valves:

1. Description:
 - a. Standard: MSS SP-110.
 - b. ANSI Class: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded or Soldered for copper piping.

- g. Seats: Reinforced PTFE.
- h. Stem: Stainless steel.
- i. Ball: Chrome plate ball, vented.
- j. Port: Full.
- k. Operator: Hand Lever.

2.4 BUTTERFLY VALVES

A. Single-Flange, Butterfly Valves:

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.
- h. Operator: 10 Position Hand Lever for less than 6", Gear Actuator for 6" and larger.
- i. Other: Valves and Seats shall be rated for 150 psi shutoff during dead-end service, without downstream piping or flange.

B. Grooved-End, Butterfly Valves (Cast Brass):

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 300 psig.
- c. Body Material: Cast brass.
- d. Stem: Two-piece stainless steel.
 - 1) Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
- e. Disc: Aluminum-bronze.
- f. Seal: Pressure-responsive EPDM.
- g. Copper-tube dimensioned grooved ends.

C. Grooved-End, Butterfly Valves (Iron):

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 300 psig (24" and smaller).
- c. Body Material: Coated, ductile iron.
- d. Stem: Two-piece stainless steel.
 - 1) Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
- e. Disc: Coated, ductile iron.

- f. Seal: EPDM.
 - 1) Pressure responsive in sizes 12" and smaller.

2.5 CHECK VALVES

A. Lift Check Valves:

1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Design: Vertical flow.
- e. Body Material: ASTM B 61 or ASTM B 62, bronze.
- f. Ends: Threaded or Soldered for copper piping.
- g. Disc: Reinforced PTFE.
- h. Cap: Threaded.

B. Globe Body Silent Check Valves:

1. Description:

- a. ANSI Class: 125
- b. Body Material: ASTM A 48, Class 35, cast iron.
- c. Disc Material: Cast Iron with Bronze Face Rings
- d. Ends: Flanged or Wafer.
- e. Trim: Bronze.
- f. Spring Material: Stainless Steel T304 (ASTM A 276).

C. Bronze Swing Check Valves:

1. Description:

- a. Standard: MSS SP-80, Type 3.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Design: Horizontal flow.
- e. Body Material: ASTM B 62, bronze.
- f. Ends: Threaded or Soldered for copper piping.
- g. Disc: Reinforced PTFE.
- h. Cap: Threaded.

D. Iron Swing Check Valves:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Design: Clear or full waterway.

- e. Body Material: ASTM A 126, cast iron.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.
- i. Cap: Bolted.

E. Cast Steel Swing Check Valves:

1. Description:

- a. ANSI Class: 300
- b. Body Material: ASTM A 216, cast steel.
- c. Disc Material (2" to 4"): Steel (ASTM A 217, Gr. CA-15).
- d. Disc Material (6" to 12"): Steel with Hard Faced (ASTM A 216, Gr. WCB).
- e. Ends: Flanged.
- f. Seat Ring Material: Stellite hard facing over plain carbon steel.
- g. Bonnet: Bolted.

F. Grooved-End, Spring-Assisted Swing Check Valves

1. Description:

- a. CWP Rating:
 - 1) 12" and smaller: 300 psig.
 - 2) 14" to 24": 230 psig.
- b. Body Material: ASTM A 536, ductile iron.
- c. Seal: EPDM.
- d. Disc: Spring-operated, ductile iron or stainless steel.
- e. Installation: Vertical or horizontal.

2.6 COMBINATION BALANCING AND SHUTOFF VALVES

A. Calibrated Ball Type or Venturi Combination Balancing and Shutoff Valves:

1. Description:

- a. CWP Rating: 125 psig.
- b. Body Material: Brass or Bronze (ASTM B 62)
- c. Ends: Flanged, Threaded or Soldered for copper piping.
- d. Seat Material: Double-seated Teflon.
- e. Ball Material: Stainless Steel.
- f. Stem Material: Brass/Bronze sealed with blow-out proof EPDM O-Ring.
- g. Operator: Lever with memory stop.

2.7 GATE VALVES

A. Bronze Gate Valves:

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. ANSI Class: 150
- c. CWP Rating: 300 psig.
- d. Body Material: ASTM B 62, cast bronze.
- e. Ends: Threaded.
- f. Stem: Non-Rising.
- g. Disc: Solid wedge; bronze.
- h. Packing: Asbestos free.
- i. Bonnet: Union
- j. Operator: Hand Wheel-Malleable iron.

B. Iron Gate Valves:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. ANSI Class: 125
- c. CWP Rating: 200 psig.
- d. Body Material: ASTM A 126, cast iron.
- e. Ends: Flanged.
- f. Wedge and Seat Rings Material: Cast bronze.
- g. Disc: Solid Wedge-Cast iron.
- h. Packing and Gasket: Asbestos free.
- i. Bonnet: Bolted
- j. Stem: O.S. & Y.
- k. Operator: Hand Wheel-Cast iron.

C. Forged Carbon Steel Gate Valves:

1. Description:

- a. ANSI Class: 300 or 600
- b. Body Material: ASTM A 105, forged carbon steel.
- c. Ends: Flanged or weld.
- d. Seat Ring Material: Hard faced stainless steel (Type 410).
- e. Disc: Solid Wedge-Stainless steel (Type 410).
- f. Bonnet: Bolted
- g. Packing and Gasket: Asbestos free.
- h. Stem: O.S. & Y.
- i. Operator: Hand Wheel-Malleable iron.

D. Cast Steel Gate Valves:

1. Description:

- a. ANSI Class: 300
- b. Body Material: ASTM A 216, cast steel.
- c. Ends: Flanged.
- d. Seat Ring Material: Stellite hard facing over plain carbon steel.
- e. Disc: Stainless steel (ASTM A 217).
- f. Bonnet: Bolted.

- g. Stem: O.S. & Y.
- h. Operator: Hand Wheel-Malleable iron.

2.8 GLOBE VALVES

A. Bronze Globe Valves:

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. ANSI Class: 150
- c. Body Material: ASTM B 62, bronze.
- d. Ends: Threaded or Flanged.
- e. Stem: Rising.
- f. Disc: 420 Stainless Steel.
- g. Seat Ring Material: 420 Stainless Steel.
- h. Bonnet: Union.
- i. Operator: Hand Wheel-Malleable iron.

B. Iron Globe Valves:

1. Description:

- a. Standard: MSS SP-85, Type I.
- b. ANSI Class: 125
- c. Body Material: ASTM A 126, cast iron.
- d. Disc Material: ASTM B 62; Bronze.
- e. Seat Ring Material: ASTM B 62; Bronze.
- f. Ends: Flanged.
- g. Bonnet: Bolted.
- h. Stem: O.S. & Y.
- i. Operator: Hand Wheel-Cast or malleable iron.

C. Forged Steel Globe Valves:

1. Description:

- a. ANSI Class: 300 or 600
- b. Body Material: ASTM A 105, forged steel.
- c. Disc Material: Loose-Stainless Steel (Type 410).
- d. Seat Material (Class 300): Integral Hard Faced.
- e. Seat Material (Class 600): Renewable Stainless Steel (Type 410)
- f. Ends: Flanged or Butt Weld.
- g. Bonnet: Bolted.
- h. Stem: O.S. & Y.
- i. Operator: Hand Wheel-Malleable iron.

D. Cast Steel Globe Valves:

1. Description:

- a. ANSI Class: 300
- b. Body Material: ASTM A 216, cast steel.
- c. Disc Material: Stainless steel.
- d. Seat Ring Material: Stellite hard facing over plain carbon steel.
- e. Ends: Flanged.
- f. Bonnet: Bolted.
- g. Stem: O.S. & Y.
- h. Operator: Hand Wheel, Hand Lever or Gear Actuator for 6" and larger.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.
- F. Examine grooved ends for form and cleanliness. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.

3.2 VALVE INSTALLATION

- A. Install valves at locations shown on the Drawings, per the Specifications and in accordance with manufacturer's written instructions.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings (the couplings shall serve as disconnect points if required).
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with handwheel and stem at or above center of pipe.
- F. Install valves in position to allow full stem movement.

- G. Install chainwheels on operators for all valves located with the lowest portion of its handwheel or lever at 10' or more above finished floor. Extend chains to 5' above finished floor.
- H. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.
- I. Install Combination Balancing and Shutoff Valves at each branch connection to return main.
- J. Install Start/Stop flow valve for isolation at each branch connection to supply main.
- K. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- L. All check valves should be installed in a location that has smooth and laminar flow conditions.
- M. For swing type check valves, locate valve a minimum of 10 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 5 pipe diameters downstream of valve.
- N. For silent type check valves, locate valve a minimum of 4 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 3 pipe diameters downstream of valve.
- O. Valves installed in copper lines shall be provided with screwed or flanged adapters with a union installed downstream and within 12" of the valve.
- P. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on the Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If 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.

3.5 PLUMBING SYSTEMS

A. Pipe NPS 2 and Smaller:

1. Shutoff: Ball Valves.
2. Prevent Backflow: Lift Check Valves or Bronze Swing Check Valves.
3. Regulate/Balance Flow: Calibrated Ball Type or Venturi Combination Balancing Shutoff Valves.

B. Pipe NPS 2-1/2 and Larger:

1. Shutoff: Butterfly Valves.
2. Prevent Backflow: Iron Swing Check Valves or Globe Body Silent Check Valves.
3. Regulate/Balance Flow: Venturi Butterfly or Venturi Globe Type Combination Balancing and Shutoff Valves.

END OF SECTION 22 05 23

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning system.
10. Equipment supports.

1.2 DEFINITIONS

- A. MSS:** Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology:** As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 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 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.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.
2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - a. Trapeze pipe hangers.
 - b. Metal framing systems.
 - c. Fiberglass strut systems.
 - d. Pipe stands.
 - e. Pipe positioning system.
 - f. Equipment supports.
3. 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.
 - a. Detail fabrication and assembly of trapeze hangers.
 - b. Design Calculations: Calculate requirements for designing trapeze hangers.

B. Informational Submittals:

1. Welding certificates.

C. Closeout Submittals:

1. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. SMACNA.
- D. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.
- E. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified,

registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. B-line Systems, Inc; a division of Cooper Industries.
 - 2. Carpenter & Paterson, Inc.
 - 3. ERICO/Michigan Hanger Co.
 - 4. Globe Pipe Hanger Products, Inc.
 - 5. Grinnell Corp.
 - 6. National Pipe Hanger Corporation.
 - 7. PHD Manufacturing, Inc.
- B. 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 or stainless steel.
- C. Saddles
 - 1. Material Galvanized Steel, 180-degree shape, each saddle marked with insulation O.D. Standard manufacturers gauge per insulated pipe size.
- D. 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.
- E. 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 or stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers:
 - 1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
 - 2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.
- B. Strap-Type, Fiberglass Pipe Hangers:
 - 1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
 - 2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Unistrut Corporation; Atkore Int.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. Thomas & Betts Corporation.
 - e. 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 intumed 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 or Hot-dipped galvanized
 - 8. Paint Coating: Acrylic.
- B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Anvil International; a subsidiary of Mueller Water Products Inc.
 - b. ERICO International Corporation.
 - c. PHD Manufacturing, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with 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. Coating: Zinc or Paint.

2.5 FIBERGLASS STRUT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. Power-Strut; Atkore Int.
 2. Champion Fiberglass, Inc.
 3. Cooper B-Line, Inc.
 4. SEASAFE, INC.; a Gibraltar Industries Company.
- B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
 1. Channels: Continuous slotted fiberglass channel with inturned lips.
 2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. Carpenter & Paterson, Inc.
 2. ERICO International Corporation.
 3. National Pipe Hanger Corporation.
 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig, or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 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 V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel 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 or stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:

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.

2.9 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.

2.10 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.11 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
 - D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
 - E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
 - F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
 - G. Fastener System Installation:
 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
 - H. Pipe Stand Installation:
 1. Pipe Stand Types except Curb-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.
 - I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
 - J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
 - K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
 - L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - M. Install lateral bracing with pipe hangers and supports to prevent swaying.
 - N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts

before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- Q. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers, fiberglass pipe hangers, fiberglass strut systems, and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. 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.
 - 5. 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.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 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.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. 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 allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.
2. Samples: For color, letter style, and graphic representation required for each identification material and device.
3. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
4. Valve numbering scheme.

B. Closeout Submittal:

1. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger

lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-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-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-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-quarters the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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: Size letters according to ASME A13.1 for piping.

2.4 STENCILS

- A. Stencils for Piping:
 - 1. Lettering Size: Size letters according to ASME A13.1 for piping.
 - 2. Stencil Material: Fiberboard or metal.
 - 3. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 4. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
- B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:
 - 1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
 - 2. Stencil Material: Fiberboard or metal.

3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain, or beaded chain, or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- 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.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, 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.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve or control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.
 - 2. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 3. Sanitary Waste and Storm Drainage Piping:

- a. Background Color: Safety green.
 - b. Letter Color: White.
- 4. Fuel Gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
- 5. Laboratory Gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and 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: 1-1/2 inches, round.
 - 2. Valve-Tag Colors: Natural.
 - 3. Letter Colors: Black.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating plumbing piping systems.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 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.
- B. Protection: Do not permit mineral fiber or calcium silicate insulation to get wet. Mineral fiber or calcium silicate insulation that is or has been wet shall be removed from the project site.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.

- B. Coordinate clearance requirements with piping Installer for piping insulation application.

1.6 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.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Pittsburgh Corning Corporation.
 - b. Approved equal.
 - 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-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 8. Properties:
 - a. Maximum Operating Temperature: 900 deg F.
 - b. Minimum Operating Temperature: -450 deg F.
 - c. Maximum Thermal Conductivity at 200 deg F Mean Temperature: 0.40 Btu-in/hr-ft²-deg F.

- d. Density: 7.2 pounds per cubic foot.
 - e. Minimum Compressive Strength: 90 psi.
 - f. Maximum Water Vapor Permeability: 0.00 perm-inches.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Properties:
 - a. Maximum Operating Temperature: 180 deg F.
 - b. Minimum Operating Temperature: -70 deg F.
 - c. Maximum Thermal Conductivity at 75 deg F Mean Temperature: Thickness 1 Inch or Less: 0.245 Btu-in/hr-ft²-deg F.
 - d. Maximum Water Vapor Permeability Thickness 1 Inch or Less: 0.05 perm-inches.
 - e. Maximum Water Absorption by Volume: 0.2%.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 4. Properties:
 - a. Maximum Thermal Conductivity at 75 deg F Mean Temperature:
 - 1) Density 3.0 PCF: 0.23 Btu-in/hr-ft²-deg F.
 - 2) Density 6.0 PCF: 0.23 Btu-in/hr-ft²-deg F.

b. Minimum Compressive Strength at 10% Deformation:

- 1) Density 3.0 PCF: 25 lb/ft².
- 2) Density 6.0 PCF: 200 lb/ft².

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.

- a. CertainTeed Corp.
- b. Johns Manville.
- c. Knauf Insulation.
- d. Manson Insulation Inc.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 2. Service Temperature Range: 0 to 180 deg F.
 - 3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 4. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 - 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 4. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: 60 percent by volume and 66 percent by weight.
 - 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 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. All-Service Jacket (ASJ): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.
2. All-Service Jacket – Self-Sealing Lap (ASJ-SSL): ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.
3. Foil-Scrim Kraft (FSK) Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Maximum water vapor permeance 0.02 perms.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.9 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.

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. Adhesive as recommended by jacket material manufacturer.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Johns Manville; Ceel-Co or Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Color: White unless indicated otherwise.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
- D. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
 - b. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
 - 2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
 - b. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
- E. Self-Adhesive Indoor or Outdoor Jacket: Multiple-ply laminated vapor barrier and waterproofing membrane for installation over insulation; consisting of aluminum, Tedlar, or laminate sheet with integral acrylic peel-and-stick adhesive with white, silver, or black facing as indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. 3M; VentureClad.

b. Polyguard Products, Inc.; Alumaguard 60.

- F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
- G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
 - 1. 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.
- B. Protective Shielding Piping Enclosures:
 - 1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 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.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. 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 with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation in accordance with manufacturers' instructions.
- B. 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.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system.
- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing. Mineral fiber or calcium silicate insulation that is or has been wet shall be removed from the job site.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches on center.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.
 - 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.
- N. Cut insulation in a manner to avoid compressing insulation to less than 75 percent of its nominal thickness.
- O. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- Q. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in firestopping section.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in firestopping section.
- 3.5 GENERAL PIPE INSULATION INSTALLATION
- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is more. 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 more. 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 more.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness

over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER 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 on center.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches on center 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-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped along length of roll with 2-inch-overlap seal. 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.

3.9 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

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 indicated. All insulation on exposed piping shall be painted white. 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 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1-1/4 or Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1/2 inch thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I: 1/2 inch thick.
2. NPS 1-1/2 or Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 or Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

C. Domestic Chilled Water (Potable):

1. NPS 6 or Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
2. NPS 8 or Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.

- b. Flexible Elastomeric: 1-1/2 inch thick.
- D. Storm Water, Roof Drain, and Overflow Roof Drain (Including Drain Bodies):
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be as described in Protective Shielding Guards article above.
- F. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
- G. Exposed Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- H. Hot Service Drains or Vents:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1-1/2 inches thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 4 inches thick.
 - b. Flexible Elastomeric: 3 inches thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. All Pipe Sizes: Insulation shall be one of the following:

- a. Cellular Glass: 4 inches thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.
- C. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 3 inches thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- D. Hot Service Drains or Vents:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 3 inches thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.12 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: None.
- D. Piping, Exposed:
 - 1. None.
 - 2. PVC, Color-Coded by System: 20 mils thick.
 - 3. Aluminum, Smooth: 0.020 inch thick.
 - 4. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.016 inch thick.

3.13 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, Color-Coded by System: 30 mils thick.
 - 3. Aluminum, Smooth: 0.024 inch thick.
 - 4. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Stucco Embossed: 0.016 inch thick.
- D. Piping, Exposed:

1. PVC: 30 mils thick.
2. Aluminum, Smooth or Stucco Embossed with Z-Shaped Locking Seam: 0.032 inch thick.
3. Stainless Steel, Type 304 or 316, Smooth 2B Finish or Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

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SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

1.2 ACTION SUBMITTALS

- A. Product Data:** For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.**
- B. Field quality-control reports.**

1.4 FIELD CONDITIONS

- A. Interruption of Existing Water Service:** Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
1. Notify Owner's representative no fewer than two days in advance of proposed interruption of water service.
 2. Do not interrupt water service without Owner's representative's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L 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. Bronze Flanges: ASME B16.24, 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.
- G. Copper Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Elkhart Products Corporation.
 - b. NIBCO Inc.
 - c. Viega.
 - 2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- H. Copper-Tube, Extruded-Tee Connections:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. T-Drill Industries Inc.
 - 2. Description: Tee formed in copper tube according to ASTM F 2014.
- I. Appurtenances for Grooved-End Copper Tubing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Anvil International.
 - b. Shurjoint Piping Products.
 - c. Victaulic Company.
2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 copper tube or ASTM B 584 bronze castings.
3. Mechanical Couplings for Grooved-End Copper Tubing:
 - a. Copper-tube dimensions and design similar to AWWA C606.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating: 300 psig.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

E. Appurtenances for Grooved-End, Ductile-Iron Pipe:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Shurjoint Piping Products.
 - b. Star Pipe Products.
 - c. Victaulic Company.

2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
 - a. AWWA C606 for ductile-iron-pipe dimensions.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating:
 - 1) NPS 14 to NPS 18: 250 psig
 - 2) NPS 20 to NPS 46: 150 psig

2.4 PEX TUBE AND FITTINGS

- A. PEX Distribution System: ASTM F 877, SDR 9 tubing.
- B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.
- C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.5 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch 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.
- F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.6 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.

2.7 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 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.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
2. Description:
 - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Colonial Engineering, Inc.
 - b. NIBCO Inc.
 - c. Spears Manufacturing Company.

2. Description:

- a. CPVC four-part union.
- b. Brass or stainless-steel threaded end.
- c. Solvent-cement-joint or threaded plastic end.
- d. Rubber O-ring.
- e. Union nut.

2.8 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. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 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.
- 2. Standard: ASSE 1079.
- 3. Pressure Rating: 125 psig minimum at 180 deg F.
- 4. 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. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Watts; a division of Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.
- 2. Standard: ASSE 1079.
- 3. Factory-fabricated, bolted, companion-flange assembly.
- 4. Pressure Rating: 125 psig minimum at 180 deg F.
- 5. 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. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
 - f. .
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- H. Install domestic water piping level without pitch and plumb.
- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. 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.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping to permit valve servicing.
- N. 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.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install PEX piping with loop at each change of direction of more than 90 degrees.
- R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 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," "Braze 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. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

- I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- M. Joints for PEX Piping: Join according to ASTM F 1807.
- N. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 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 and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
- J. Install hangers for vertical PEX piping every 48 inches.

- K. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
 - 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
 - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 - 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 - 5. NPS 6: 48 inches with 3/4-inch rod.
 - 6. NPS 8: 48 inches with 7/8-inch rod.
- L. Install supports for vertical PP piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- M. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. 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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.8 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.
 - 2) 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 not air bound and that piping is full of 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 static water pressure of 50 psig 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.

3.9 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.

3.10 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 of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. 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.

3.11 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. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. PP, SDR 11 socket fittings; and fusion-welded joints.
- D. Aboveground domestic water piping, NPS 2 and smaller shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 - 2. PEX tube, NPS 1 and smaller; fittings for PEX tube; and crimped joints.
 - 3. PP, SDR 11 socket fittings; and fusion-welded joints.
- E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

3.12 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 or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 22 11 16

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose stations.
9. Hose bibbs.
10. Wall hydrants.
11. Post hydrants.
12. Drain valves.
13. Water-hammer arresters.
14. Air vents.
15. Trap-seal primer valves.
16. Specialty valves.
17. Flexible connectors.

1.2 ACTION SUBMITTALS

- A. Product Data:** For each type of product.
- B. Shop Drawings:** For domestic water piping specialties.
1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.**

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:** For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: **125 psig** unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 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:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; a division of Watts Water Technologies, Inc.
 - e. Rain Bird Corporation.
 - f. Toro Company (The); Irrigation Div.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 3. Standard: ASSE 1001.
 - 4. Size: **NPS 1/4 to NPS 3**, as required to match connected piping.
 - 5. Body: Bronze.
 - 6. Inlet and Outlet Connections: Threaded.
 - 7. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers
 - 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:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Arrowhead Brass Products.
 - b. Cash Acme; a division of Reliance Worldwide Corporation.

- c. Conbraco Industries, Inc.
 - d. Legend Valve.
 - e. MIFAB, Inc.
 - f. Prier Products, Inc.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - j. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1011.
 4. Body: Bronze, nonremovable, with manual drain.
 5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 6. Finish: Chrome or nickel plated

C. Pressure Vacuum Breakers

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of 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. Flomatic Corporation.
 - e. Toro Company (The); Irrigation Div.
 - f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1020.
4. Operation: Continuous-pressure applications.
5. Pressure Loss: **5 psig** maximum, through middle third of flow range.
6. Size: See Drawings
7. Design Flow Rate: See Drawings
7. Selected Unit Flow Range Limits: See Drawings
8. Pressure Loss at Design Flow Rate: See Drawings
9. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

D. Spill-Resistant Vacuum Breakers

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:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
3. Standard: ASSE 1056.
4. Operation: Continuous-pressure applications.
5. Size: **NPS 1/4** or **NPS 3/8** or **NPS 1/2** or **NPS 3/4** or **NPS 1**.
6. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of 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. Honeywell International Inc.
 - e. Legend Valve.
 - f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - g. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1012.
4. Operation: Continuous-pressure applications.
5. Size: **NPS 1/2** or **NPS 3/4**.
6. Body: Bronze.
7. End Connections: Union, solder joint.
8. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of 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. Flomatic Corporation.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
- 3. Standard: ASSE 1013.
 - 4. Operation: Continuous-pressure applications.
 - 5. Pressure Loss: **12 psig** maximum, through middle third of flow range.
 - 6. Size: See Drawings
 - 7. Design Flow Rate: See Drawings
 - 8. Selected Unit Flow Range Limits: See Drawings
 - 9. Body: Bronze for **NPS 2** and smaller; steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for **NPS 2-1/2** and larger.
 - 10. End Connections: Threaded for **NPS 2** and smaller; flanged for **NPS 2-1/2** and larger.
 - 11. Configuration: Designed for horizontal, straight-throughflow.
 - 12. Accessories:
 - a. Valves **NPS 2** and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves **NPS 2-1/2** 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.

C. Double-Check, Backflow-Prevention Assemblies

- 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:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of 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. Flomatic Corporation.
 - e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - f. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
- 3. Standard: ASSE 1015.
 - 4. Operation: Continuous-pressure applications unless otherwise indicated.
 - 5. Pressure Loss: **5 psig** maximum, through middle third of flow range.
 - 6. Body: Bronze for **NPS 2** and smaller; cast iron or steel with interior lining that complies with AWWA C550 or that is FDA approved for **NPS 2-1/2** and larger.
 - 7. End Connections: Threaded for **NPS 2** and smaller; flanged for **NPS 2-1/2** and larger.
 - 8. Configuration: Designed for horizontal, straight-through flow.

9. Accessories:

- a. Valves **NPS 2** and Smaller: Ball type with threaded ends on inlet and outlet.
- b. Valves **NPS 2-1/2** and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

D. Beverage-Dispensing-Equipment Backflow Preventers

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1022.
4. Operation: Continuous-pressure applications.
5. Size: **NPS 1/4 or NPS 3/8**.
6. Body: Stainless steel.
7. End Connections: Threaded.

E. Dual-Check-Valve Backflow Preventers:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of 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. Flomatic Corporation.
 - e. Ford Meter Box Company, Inc. (The).
 - f. Honeywell International Inc.
 - g. Legend Valve.
 - h. McDonald, A. Y. Mfg. Co.
 - i. Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
 - j. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - k. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1024.
4. Operation: Continuous-pressure applications.
5. Body: Bronze with union inlet.

F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Lancer Corporation.
 - c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
3. Standard: ASSE 1032.
4. Operation: Continuous-pressure applications.
5. Size: **NPS 1/4 or NPS 3/8.**
6. Body: Stainless steel.
7. End Connections: Threaded.

G. Hose-Connection Backflow Preventers:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
3. Standard: ASSE 1052.
4. Operation: Up to **10-foot head of water** back pressure.
5. Inlet Size: **NPS 1/2 or NPS 3/4.**
6. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
7. Capacity: At least **3-gpm** flow.

H. Backflow-Preventer Test Kits:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; a division of Watts Water Technologies, Inc.
 - c. Flomatic Corporation.
 - d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

- e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Armstrong International, Inc.
 - b. Flo Fab Inc.
 - c. ITT Corporation; Bell & Gossett Div.
 - d. NIBCO Inc.
 - e. TAC.
 - f. TACO Incorporated.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
3. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
4. Body: Brass or bronze.
5. Size: Same as connected piping, but not larger than **NPS 2**.
6. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Armstrong International, Inc.
 - b. Flo Fab Inc.
 - c. ITT Corporation; Bell & Gossett Div.
 - d. NIBCO Inc.
 - e. TAC.
 - f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
3. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.

4. Size: Same as connected piping, but not smaller than **NPS 2-1/2**.
- C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- D. Memory-Stop Balancing Valves:
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:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO Inc.
 - h. Red-White Valve Corp.
 3. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
 4. Pressure Rating: **400-psig** minimum CWP.
 5. Size: **NPS 2** or smaller.
 6. Body: Copper alloy.
 7. Port: Standard or full port.
 8. Ball: Chrome-plated brass.
 9. Seats and Seals: Replaceable.
 10. End Connections: Solder joint or threaded.
 11. Handle: Vinyl-covered steel with memory-setting device.
- E. Primary, Thermostatic, Water Mixing Valves:
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:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Armstrong International, Inc.
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. Powers; a division of Watts Water Technologies, Inc.
 - e. Symmons Industries, Inc.
 3. Standard: ASSE 1017.
 4. Pressure Rating: **125 psig** minimum unless otherwise indicated.
 5. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
 6. Material: Bronze body with corrosion-resistant interior components.
 7. Connections: Threaded inlets and outlet.

8. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Tempered-Water Setting: 120 **deg F**.
10. Valve Finish: Rough bronze.

F. Individual-Fixture, Water Tempering Valves:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.
 - c. Honeywell International Inc.
 - d. Lawler Manufacturing Company, Inc.
 - e. Leonard Valve Company.
 - f. Powers; a division of Watts Water Technologies, Inc.
 - g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
3. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
4. Pressure Rating: **125 psig** minimum unless otherwise indicated.
5. Body: Bronze body with corrosion-resistant interior components.
6. Temperature Control: Adjustable.
7. Inlets and Outlet: Threaded.
8. Finish: Rough or chrome-plated bronze.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: **125 psig** minimum unless otherwise indicated.
2. Body: Bronze for **NPS 2** and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for **NPS 2-1/2** and larger.
3. End Connections: Threaded **for NPS 2** and smaller; flanged for **NPS 2-1/2** and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers **NPS 2** and Smaller: **0.020 inch**.
 - b. Strainers **NPS 2-1/2 to NPS 4**: **0.045 inch**.

2.7 OUTLET BOXES

A. Icemaker Outlet Boxes:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. LSP Products Group, Inc.
 - d. Oatey.
 - e. Plastic Oddities.
3. Mounting: Recessed.
4. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
5. Faucet: Valved fitting complying with ASME A112.18.1. Include **NPS 1/2** or smaller copper tube outlet.
6. Supply Shutoff Fitting: **NPS 1/2** gate, globe, or ball valve and **NPS 1/2** copper, water tubing.

2.8 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: **NPS 1/2 or NPS 3/4** threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: **125 psig**.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products.
 - g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
3. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
4. Pressure Rating: **125 psig**.
5. Operation: Loose key.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: **NPS 3/4 or NPS 1**.
8. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
9. Box: Deep, flush mounted with cover.
10. Box and Cover Finish: Polished nickel bronze.
11. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
12. Nozzle and Wall-Plate Finish: Polished nickel bronze.
13. Operating Keys(s): Two with each wall hydrant.

2.10 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Prier Products, Inc.
 - c. Simmons Manufacturing Co.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products.
 - g. Woodford Manufacturing Company; a division of WCM Industries, Inc.

- h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
- i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

- 3. Standard: ASME A112.21.3M.
- 4. Type: Nonfreeze, exposed-outlet post hydrant.
- 5. Operation: Loose key.
- 6. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
- 7. Casing: Bronze with casing guard.
- 8. Inlet: **NPS 3/4.**
- 9. Outlet: Garden-hose thread complying with ASME B1.20.7.
- 10. Drain: Designed with hole to drain into ground when shut off.
- 11. Vacuum Breaker:
 - a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.11 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** minimum CWP.
- 3. Size: **NPS 3/4.**
- 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.

B. Gate-Valve-Type, Hose-End Drain Valves:

- 1. Standard: MSS SP-80 for gate valves.
- 2. Pressure Rating: Class 125.
- 3. Size: **NPS 3/4.**
- 4. Body: ASTM B 62 bronze.
- 5. Inlet: **NPS 3/4** threaded or solder joint.
- 6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

- 1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
- 2. Pressure Rating: **200-psig** minimum CWP or Class 125.
- 3. Size: **NPS 3/4.**

4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: **NPS 1/8** side outlet with cap.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 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.
3. Standard: ASSE 1010 or PDI-WH 201.
4. Type: Metal bellows.
5. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: **125-psig** minimum pressure rating at **140 deg F**.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: **NPS 1/2** minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: **150-psig** minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: **NPS 3/8** minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.14 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of 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.
3. Standard: ASSE 1018.
4. Pressure Rating: **125 psig** minimum.
5. Body: Bronze.
6. Inlet and Outlet Connections: **NPS 1/2** threaded, union, or solder joint.
7. Gravity Drain Outlet Connection: **NPS 1/2** threaded or solder joint.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

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:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
3. Standard: ASSE 1044, lavatory P-trap with **NPS 3/8** minimum, trap makeup connection.
4. Size: **NPS 1-1/4** minimum.
5. Material: Chrome-plated, cast brass.

2.15 FLEXIBLE CONNECTORS

- 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:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Flex-Hose Co., Inc.

2. [Flexicraft Industries.](#)
 3. [Flex Pression, Ltd.](#)
 4. [Flex-Weld Incorporated.](#)
 5. [Hyspan Precision Products, Inc.](#)
 6. [Mercer Gasket & Shim, Inc.](#)
 7. [Metraflex, Inc.](#)
 8. [Proco Products, Inc.](#)
 9. [TOZEN Corporation.](#)
 10. [Unaflex.Universal Metal Hose; a Hyspan company.](#)
- C. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum **200 psig**.
 2. End Connections **NPS 2** and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections **NPS 2-1/2** and Larger: Flanged copper alloy.
- D. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum **200 psig**.
 2. End Connections **NPS 2** and Smaller: Threaded steel-pipe nipple.
 3. End Connections **NPS 2-1/2** and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 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 memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.

- E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- G. Install water-hammer arresters in water piping according to PDI-WH 201.
- H. Install air vents at high points of water piping.
- I. 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.
- J. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test all devices and equipment 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.

3.4 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19

SECTION 22 11 24

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Manual gas shutoff valves.
 - 5. Earthquake valves.
 - 6. Pressure regulators.
 - 7. Dielectric fittings.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 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. Service meters. Indicate pressure ratings and capacities. Include meter bars and supports.
 6. 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 .
 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.

1.5 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.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.7 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.

1.8 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.

1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. 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 Construction Manager 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 Construction Manager's written permission.

1.10 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 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 2. Service Regulators: 65 psig or 100 psig minimum unless otherwise indicated.
 3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig and is reduced to secondary pressure of 0.5 psig or less.
- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 6. Mechanical Couplings:
 - a. Steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Steel bolts, washers, and nuts.
 - d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
1. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 2. Coating: PE with flame retardant.

- a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.
 3. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 4. Striker Plates: Steel, designed to protect tubing from penetrations.
 5. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 6. Operating-Pressure Rating: 5 psig.
- C. 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. Vent casing aboveground.
 - 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.
 4. Transition Service-Line Risers: Factory fabricated, and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. PE body with molded-in, stainless-steel support ring.

- b. Buna-nitrile seals.
 - c. Acetal collets.
 - d. Electro-zinc-plated steel stiffener.
- 6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Fiber-reinforced plastic body.
 - b. PE body tube.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Stainless-steel bolts, nuts, and washers.
- 7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Steel flanges and tube with epoxy finish.
 - b. Buna-nitrile seals.
 - c. Steel bolts, washers, and nuts.
 - d. Factory-installed anode for steel-body couplings installed underground.

2.3 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.
- 6. End Fittings: Zinc-coated steel.
- 7. Threaded Ends: Comply with ASME B1.20.1.
- 8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

- 1. Copper-alloy convenience outlet and matching plug connector.
- 2. Nitrile seals.
- 3. Hand operated with automatic shutoff when disconnected.
- 4. For indoor or outdoor applications.
- 5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

- 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
- 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
- 3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

D. 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 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. 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: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

- A. 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 complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 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 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig .
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: BrassCraft, Conbraco
 2. Body: Bronze, complying with ASTM B 584.
 3. Ball: Chrome-plated bronze.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 8. CWP Rating: 600 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Bronze Plug Valves: MSS SP-78.
1. Manufacturers: Lee Brass, McDonald
 2. Body: Bronze, complying with ASTM B 584.
 3. Plug: Bronze.
 4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Operator: Square head or lug type with tamperproof feature where indicated.
 6. Pressure Class: 125 psig.
 7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Manufacturers: McDonald, Mueller, Xomox
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Homestead, McDonald, Mueller
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. PE Ball Valves: Comply with ASME B16.40.
1. Manufacturers: Kerotest, Lyall, Perfection
 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.
 8. Operating Temperature: Minus 20 to plus 140 deg F.
 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.
- I. 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 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.

2.6 EARTHQUAKE VALVES

- A. Earthquake Valves, Maximum Operating Pressure of 5 psig: Comply with ASCE 25.

1. Manufacturers: Vanguard Valves
 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 3. Maximum Operating Pressure: 5 psig.
 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.
- B. Earthquake Valves, Maximum Operating Pressure of 60 psig: Comply with ASCE 25.
1. Manufacturers: Pacific Seismic
 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 3. Maximum Operating Pressure: 60 psig.
 4. Cast-aluminum body with stainless-steel internal parts.
 5. Nitrile-rubber, reset-stem o-ring seal.
 6. Valve position, open or closed, indicator.
 7. Composition valve seat with clapper held by spring or magnet locking mechanism.
 8. Level indicator.
 9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

2.7 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 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Service Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: American Meter, Fisher, Invensys
 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.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: American Meter, Fisher, Invensys
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: 10 psig .

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Eaton, Harper, Maxitrol
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 5 psig.

2.8 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: Watts, McDonald, Wilkins
2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Watts, McDonald, Wilkins
2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - 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: Pipeline Seal and Insulator, Calpico, Advanced Products & Systems
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.

2.9 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

- C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. 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.

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. 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 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 natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In 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 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 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 sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

- E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- F. Install service meters downstream from pressure regulators.
- G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel 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.

3.7 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.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 20548 "Vibration and Seismic Controls for Plumbing."
- B. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 - 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.9 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "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. Topcoat: Exterior alkyd enamel gloss.
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex gloss.
 - d. Color: Gray.
 - 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd gloss.
 - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 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 larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.14 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.15 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.
 - 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- 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. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution 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. Underground, below building, 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.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. 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.

3.17 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, branch piping **NPS 1** and smaller shall be the following:
1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 2. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
 2. Steel pipe with steel welding fittings and welded joints.
- C. Underground, below building, 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.

- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- E. 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.

3.18 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 and Smaller: Bronze plug valves.
 - 3. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

3.19 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes **NPS 2** and smaller at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, lubricated plug valve.
- E. Valves in branch piping for single appliance shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

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SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
 - 3. Encasement for underground metal piping.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste, Force-Main Piping: 50 psig.
- 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.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.4 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

2.1 PIPING MATERIALS

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. **ANACO-Husky.**
 - b. **Dallas Specialty & Mfg. Co.**
 - c. **Fernco Inc.**
 - d. **Matco-Norca, Inc.**
 - e. **MIFAB, Inc.**
 - f. **Mission Rubber Company; a division of MCP Industries, Inc.**
 - g. **Stant.**
 - h. **Tyler Pipe.**
 - 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.
- C. Heavy-Duty, Hubless-Piping Couplings:

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. **ANACO-Husky.**
 - b. **Clamp-All Corp.**
 - c. **Dallas Specialty & Mfg. Co.**
 - d. **MIFAB, Inc.**
 - e. **Mission Rubber Company; a division of MCP Industries, Inc.**
 - f. **Stant.**
 - g. **Tyler Pipe.**
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:

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. **MG Piping Products Company.**
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.
- B. Cast-Iron Drainage Fittings: ASME B16.12, threaded.
- C. Cast-Iron Flanges: ASME B16.1, Class 125.
 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch** maximum thickness unless thickness or specific material is indicated.
 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- D. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
 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. **Anvil International; a subsidiary of Mueller Water Products, Inc.**
 - b. **Grinnell Mechanical Products.**

- c. **Shurjoint Piping Products.**
 - d. **Victaulic Company.**
- 2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
 - 3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.5 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

- 1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
- 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

- 1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- 2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
- 3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:

- 1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
- 2. Ductile-Iron-Pipe Appurtenances:
 - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) **Anvil International.**
 - 2) **Shurjoint Piping Products.**
 - 3) **Star Pipe Products.**
 - 4) **Victaulic Company.**
 - b. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.

- c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.6 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 and Type M**, water tube, drawn temper.
- D. Soft Copper Tube: **ASTM B 88, Type L**, water tube, annealed temper.
- E. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, **1/8-inch** maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.7 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."

2.8 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) **Dallas Specialty & Mfg. Co.**
 - 2) **Fernco Inc.**
 - 3) **Mission Rubber Company; a division of MCP Industries, Inc.**
 - 4) **Plastic Oddities; a division of Diverse Corporate Technologies, Inc.**
 - 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) **Cascade Waterworks Mfg. Co.**
 - 2) **Mission Rubber Company; a division of MCP Industries, Inc.**
 - b. Standard: ASTM C 1460.

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

5. Pressure Transition Couplings:

- 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) Cascade Waterworks Mfg. Co.
 - 2) Dresser, Inc.
 - 3) EBAA Iron, Inc.
 - 4) JCM Industries, Inc.
 - 5) Romac Industries, Inc.
 - 6) Smith-Blair, Inc.; a Sensus company.
 - 7) The Ford Meter Box Company, Inc.
 - 8) Viking Johnson.
- b. Standard: AWWA C219.
- c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
- d. Center-Sleeve Material: Manufacturer's standard.
- e. Gasket Material: Natural or synthetic rubber.
- f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

- 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- 2. Dielectric Unions:
 - 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) Capitol Manufacturing Company.
 - 2) Central Plastics Company.
 - 3) Hart Industries International, Inc.
 - 4) Jomar International Ltd.
 - 5) Matco-Norca, Inc.
 - 6) McDonald, A. Y. Mfg. Co.
 - 7) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 8) Wilkins; a Zurn company.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

- 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) Capitol Manufacturing Company.
- 2) Central Plastics Company.
- 3) Matco-Norca, Inc.
- 4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 5) Wilkins; a Zurn company.

b. Description:

- 1) Standard: ASSE 1079.
- 2) Factory-fabricated, bolted, companion-flange assembly.
- 3) Pressure Rating: 125 psig minimum at 180 deg F.
- 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

- 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) Advance Products & Systems, Inc.
- 2) Calpico, Inc.
- 3) Central Plastics Company.
- 4) Pipeline Seal and Insulator, Inc.

b. Description:

- 1) Nonconducting materials for field assembly of companion flanges.
- 2) Pressure Rating: 150 psig.
- 3) Gasket: Neoprene or phenolic.
- 4) Bolt Sleeves: Phenolic or polyethylene.
- 5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

- 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) Elster Perfection.
- 2) Grinnell Mechanical Products.
- 3) Matco-Norca, Inc.
- 4) Precision Plumbing Products, Inc.
- 5) Victaulic Company.

b. Description:

- 1) Standard: IAPMO PS 66
- 2) Electroplated steel nipple.
- 3) Pressure Rating: 300 psig at 225 deg F.
- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

2.9 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
- C. Form: Tube.

PART 3 - EXECUTION

3.1 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 to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. 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 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping **NPS 3** and smaller; 1 percent downward in direction of flow for piping **NPS 3** and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping **NPS 2** and smaller; 1 percent downward in direction of flow for piping **NPS 3** and larger.
 - 3. Vent Piping: Down toward vertical fixture vent or toward vent stack.
 - 4. 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."
 - 5. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- M. Install steel piping according to applicable plumbing code.
- N. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. Install aboveground PVC piping according to ASTM D 2665.
- Q. Install underground ABS and PVC piping according to ASTM D 2321.
- R. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- S. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

- T. Install force mains at elevations indicated.
- U. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "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 221319 "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. 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.
- B. 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.
- C. 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.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- F. 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.
- G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- I. 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.

3.3 VALVE INSTALLATION

- A. General valve installation requirements are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sewage pump discharge.
 - 2. Install gate or full-port ball valve for piping **NPS 2** and smaller.
 - 3. Install gate valve for piping **NPS 2-1/2** and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves.
 - 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "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.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.

5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
 8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2: 84 inches with 3/8-inch rod.
 2. NPS 3: 96 inches with 1/2-inch rod.
 3. NPS 4: 108 inches with 1/2-inch rod.
 4. NPS 6: 10 feet with 5/8-inch rod.
- K. Install supports for vertical stainless-steel piping every 10 feet.
- L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
 5. NPS 6: 10 feet with 5/8-inch rod.
 6. NPS 8: 10 feet with 3/4-inch rod.
- M. Install supports for vertical copper tubing every 10 feet.
- N. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- O. Install supports for vertical ABS and PVC piping every 48 inches.
- P. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect 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. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections **NPS 2-1/2** and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping **NPS 2** and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping **NPS 2-1/2** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water**. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of **1-inch wg**. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of **50 psig** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.8 CLEANING 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.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 - 4. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 - 5. Copper DWV tube, copper drainage fittings, and soldered joints.
- C. Aboveground, soil and waste piping **NPS 5** and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 - 4. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 - 5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Aboveground, vent piping **NPS 4** and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 - 4. Stainless-steel pipe and fittings gaskets, and gasketed joints.
 - 5. Copper DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, **NPS 2-1/2 and NPS 3-1/2**: Hard copper tube, **Type M**; copper pressure fittings; and soldered joints.
 - 6. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- E. Underground, soil, waste, and vent piping **NPS 4** and smaller shall be any of the following:
 - 1. Extra Heavy class, cast-iron soil piping; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty cast-iron hubless-piping couplings; and coupled joints.
 - 3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
 - 4. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

- F. Underground, soil and waste piping **NPS 5** and larger shall be any of the following:
1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; coupled joints.
 3. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- G. Aboveground sanitary-sewage force mains **NPS 1-1/2 and NPS 2** shall be any of the following:
1. Hard copper tube, **Type L**; copper pressure fittings; and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- H. Aboveground sanitary-sewage force mains **NPS 2-1/2 to NPS 6** shall be any of the following:
1. Hard copper tube, **Type L**; copper pressure fittings; and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
 3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

END OF SECTION 22 13 16

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Air-admittance valves.
5. Roof flashing assemblies.
6. Through-penetration firestop assemblies.
7. Miscellaneous sanitary drainage piping specialties.
8. Flashing materials.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
1. FOG disposal systems.
 2. Grease interceptors.
 3. Grease removal devices.
 4. Oil interceptors.

- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

- 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:
 - 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:
 - 2. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. **Josam Company; Josam Div.**
 - b. **MIFAB, Inc.**
 - c. **Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.**
 - d. **Tyler Pipe; Wade Div.**
 - e. **Watts Drainage Products Inc.**
 - f. **Zurn Plumbing Products Group; Specification Drainage Operation.**

3. Standard: ASME A112.14.1.
4. Size: Same as connected piping.
5. Body: Cast iron.
6. Cover: Cast iron with bolted or threaded access check valve.
7. End Connections: Hub and spigot or hubless.
8. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
9. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Horizontal, Plastic Backwater Valves:

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:
2. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Canplas LLC.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Oatey.
 - e. Plastic Oddities; a division of Diverse Corporate Technologies.
 - f. Sioux Chief Manufacturing Company, Inc.
 - g. Zurn Plumbing Products Group; Light Commercial Operation.
3. Size: Same as connected piping.
4. Body: PVC.
5. Cover: Same material as body with threaded access to check valve.
6. Check Valve: Removable swing check.
7. End Connections: Socket type.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:
 - 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:
 - b. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe.
 - 5) Watts Drainage Products.

6) Zurn Plumbing Products Group.

2. ASME A112.3.1, Stainless-Steel Cleanouts:

- 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:
- b. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1) Josam Company.

- 3. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
- 4. Size: Same as connected drainage piping
- 5. Body Material: Hubless, cast-iron soil pipe test tee or as required to match connected piping.
- 6. Closure: Countersunk, brass plug.
- 7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 8. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

- 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:
- b. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

- 1) Josam Company.
- 2) Oatey.
- 3) Sioux Chief Manufacturing Co., Inc.
- 4) Smith, Jay R. Mfg. Co.
- 5) Tyler Pipe.
- 6) Watts Drainage Products.
- 7) Zurn Plumbing Products Group.

C. Cast-Iron Wall Cleanouts:

- 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:
- 2. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.

- c. **Smith, Jay R. Mfg. Co.**
 - d. **Tyler Pipe**; Wade Div.
 - e. **Watts Drainage Products.**
 - f. **Zurn Plumbing Products Group**; Specification Drainage Operation.
- 3. Standard: ASME A112.36.2M. Include wall access.
 - 4. Size: Same as connected drainage piping.
 - 5. Body: Hubless, cast-iron soil pipe test tee or as required to match connected piping.
 - 6. Closure: Countersunk or raised-head, brass plug.
 - 7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 8. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
 - 9. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. Plastic Floor Cleanouts:

- 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:
- 2. **Basis-of-Design Product**: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. **Canplas LLC.**
 - b. **IPS Corporation.**
 - c. **NDS Inc.**
 - d. **Plastic Oddities.**
 - e. **Sioux Chief Manufacturing Company, Inc.**
- 3. Size: Same as connected branch.
- 4. Body: PVC.
- 5. Closure Plug: PVC.
- 6. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

- 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:
- 2. **Basis-of-Design Product**: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. **Commercial Enameling Co.**
 - b. **Josam Company**; Josam Div.
 - c. **MIFAB, Inc.**

- d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products.
 - h. Zurn Plumbing Products Group
- 3. Standard: ASME A112.6.3.
 - 4. Pattern: Floor drain.
 - 5. Body Material: Gray iron.
 - 6. Anchor Flange: Required.
 - 7. Clamping Device: Required.
 - 8. Outlet: Bottom.
 - 9. Top or Strainer Material: Nickel bronze.
 - 10. Top Shape: Round.
 - 11. Top Loading Classification: Heavy Duty.
 - 12. Trap Material: Cast iron.
 - 13. Trap Pattern: Standard P-trap.

2.4 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves <Insert drawing designation if any>:

- 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:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Ayrlett, LLC.
 - b. Durgo, Inc.
 - c. Oatey.
 - d. ProSet Systems Inc.
 - e. RectorSeal.
 - f. Studor, Inc.
- 3. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
- 4. Housing: Plastic.
- 5. Operation: Mechanical sealing diaphragm.
- 6. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

- 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:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Durgo, Inc.
 - b. Oatey.

c. **Studor, Inc.**

3. Standard: ASSE 1050 for vent stacks.
4. Housing: Plastic.
5. Operation: Mechanical sealing diaphragm.
6. Size: Same as connected stack vent or vent stack.

C. Wall Box:

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:
2. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. **Durgo, Inc.**
 - b. **Oatey.**
 - c. **RectorSeal.**
 - d. **Studor, Inc.**
3. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
4. Size: About **9 inches wide by 8 inches high by 4 inches deep.**

2.5 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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:
2. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. **Acorn Engineering Company; Elmdor/Stoneman Div.**
 - b. **Thaler Metal Industries Ltd.**
3. Description: Manufactured assembly of flashing collar and skirt extending at least **6 inches** from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.
 - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. **ProSet Systems Inc.**
 - b.
3. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
4. Size: Same as connected soil, waste, or vent stack.
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.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with **NPS 1/2** side inlet.

C. 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.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend **1 inch** above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

H. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.8 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.9 MOTORS

- A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to **NPS 4**. Use **NPS 4** for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of **50 feet** for piping **NPS 4** and smaller and **100 feet** for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, **30 Inches** or Less: Equivalent to 1 percent slope, but not less than **1/4-inch** total depression.
 - b. Radius, **30 to 60 Inches**: Equivalent to 1 percent slope.
 - c. Radius, **60 Inches** or Larger: Equivalent to 1 percent slope, but not greater than **1-inch** total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

- E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- F. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.
- G. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- H. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- I. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- J. Install fixture air-admittance valves on fixture drain piping.
- K. Install stack air-admittance valves at top of stack vent and vent stack piping.
- L. Install air-admittance-valve wall boxes recessed in wall.
- M. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- N. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- O. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- P. Assemble open drain fittings and install with top of hub **1 inch** above floor.
- Q. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- R. 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.
- S. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- T. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- U. Install vent caps on each vent pipe passing through roof.

- V. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain **1-inch** clearance between vent pipe and roof substrate.
- W. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- X. Install frost-proof vent caps on each vent pipe passing through roof. Maintain **1-inch** clearance between vent pipe and roof substrate.
- Y. Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.
- Z. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 - 1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
 - 2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
 - 3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
 - 4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- AA. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.
- BB. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Section 231113 "Facility Fuel-Oil Piping."
- CC. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.
- DD. Install wood-blocking reinforcement for wall-mounting-type specialties.
- EE. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "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.
- C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
- D. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.
- E. Grease Removal Devices: Connect controls, electrical power, factory-furnished accessories, and inlet, outlet, and vent piping to unit.
- F. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.
- G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. FOG disposal systems.
 - 2. Grease interceptors.
 - 3. Grease removal devices.
 - 4. Oil interceptors.
 - 5. Solids interceptors.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 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.

3.6 PROTECTION

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

END OF SECTION 22 13 19

SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
 - 3. Encasement for underground metal piping.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Storm Drainage, Force-Main Piping: 50 psig.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy classes.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Husky, Fernco, MIFAB, Mission, Tyler
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stops.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight. Include square-cut-grooved or threaded ends matching joining method.
- B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12 threaded.
- C. Steel-Pipe Pressure Fittings:
 - 1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.5 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."

2.6 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. Standard: ASTM C 1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. 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. Standard: ASTM C 1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

- a. Standard: AWWA C219.
- b. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.
- c. Center-Sleeve Material: Manufacturer's standard.
- d. Gasket Material: Natural or synthetic rubber.
- e. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 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 from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 1 downward in direction of flow.
- M. 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."
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground PVC piping according to ASTM D 2665.
- P. Install underground PVC piping according to ASTM D 2321.
- Q. Install force mains at elevations indicated.
- R. Plumbing Specialties:
 - 1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
 - 3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
- S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

- B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 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: Unshielded, nonpressure transition couplings.
 - 3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force-Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "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.
 - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 6. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 - 6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3: 12 feet with 1/2-inch rod.

6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
 8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 5. NPS 6: 10 feet with 5/8-inch rod.
 6. NPS 8: 10 feet with 3/4-inch rod.
- K. Install supports for vertical copper tubing every 10 feet.
- L. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
 5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.
- M. Install supports for vertical PVC piping every 48 inches.
- N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 2. Comply with requirements for cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Connect force-main piping to the following:
1. Storm Sewer: To exterior force main.
 2. Sump Pumps: To sump pump discharge.

- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.8 CLEANING

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

3.9 PIPING SCHEDULE

- A. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
 - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- B. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
 - 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
- C. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
 - 1. Extra Heavy or Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
 - 1. Extra Heavy or Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

- E. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 shall be the following:
 - 1. Galvanized-steel pipe, pressure fittings, and threaded joints.
- F. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be the following:
 - 1. Galvanized-steel pipe, pressure fittings, and threaded joints.
 - 2. Fitting-type transition couplings if dissimilar pipe materials.

END OF SECTION 22 14 13

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SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof drains.
 - 2. Cleanouts.
 - 3. Backwater valves.
 - 4. Trench drains.
 - 5. Channel drainage systems.
 - 6. Through-penetration firestop assemblies.
 - 7. Flashing materials.

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

- A. Cast-Iron, General-Purpose Roof Drains, Downspout Nozzles, Promenade Roof Drains:
 - 1. Manufacturers: Josam, MIFAB, Jay R. Smith, Watts, Wade, Zurn.

2.2 CLEANOUTS

- A. Floor Cleanouts:
 - 1. Manufacturers: Josam, MIFAB, Jay R. Smith, Watts, Wade, Zurn
 - 2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.

3. Size: Same as connected branch.
4. Body or Ferrule Material: Cast iron.
5. Outlet Connection: Inside calk.
6. Closure: Brass plug with straight threads and gasket.
7. Adjustable Housing Material: Cast iron with set-screws or other device and Finish: Polished bronze.
8. Frame and Cover Shape: Round.
9. Top-Loading Classification: Heavy Duty.
10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Wall Cleanouts:

1. Manufacturers: Josam, MIFAB, Jay R. Smith, Watts, Zurn.
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, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Install expansion joints, if indicated, in roof drain outlets.
 - 3. Position roof drains for easy access and maintenance.
- 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. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet 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 trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- G. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- H. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 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 if required:
 - 1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

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

END OF SECTION 22 14 23

SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Submersible sump pumps.
 - 2. Sump-pump basins and basin covers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Submersible Pumps: Liberty, Zoeller, Little Giant, Grundfos, Hydromatic

2.2 SIMPLEX SUBMERSIBLE SUMP PUMPS

- A. Submersible Sump Pumps
 1. Description: Factory-assembled and -tested effluent-pump unit.
 2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump.
 3. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 4. Impeller: Statically and dynamically balanced, non-clogging vortex, closed or semi-open design for clear wastewater, and keyed and secured to shaft.
 5. Pump and Motor Shaft: Steel, with factory-sealed, grease-lubricated ball bearings.
 6. Seal: Mechanical.
 7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Oil.
 8. Float Switch Controls:
 - a. Enclosure: NEMA 1, wall-mounted.
 - b. Switch Type: Diaphragm level control switches.
 - c. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - d. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
 9. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) High water.
 - 3) Alarm status.
 10. Electrical Characteristics:
 - a. Volts: 120.
 - b. Phases: Single.
 - c. Hertz: 60.

2.3 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Fiberglass.
 2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
 3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.
- 2.4 MOTORS
- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing 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.
- B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. 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 motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Pumps and controls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 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.

3.6 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 14 29

SECTION 22 33 00

ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters 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."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
- C. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For commercial 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.

- B. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater, from manufacturer.
- 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. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. 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, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Three years.
 - b. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Two years.
 - c. Electric, Tankless, Domestic-Water Heaters: One year(s).
 - d. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 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. Bradford White
 - b. Lochinvar
 - c. Rheem
 - d. A.O. Smith, State.
 - 2. Standard: UL 1453.
 - 3. Storage-Tank Construction: ASME-code, steel horizontal arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.

- 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

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. Amtrol
 - b. A.O. Smith
 - c. Taco, State.
2. 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.
3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater and include drain

outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- D. Heat-Trap Fittings: ASHRAE 90.2.
- E. Recirculating pumps
 - 1. In-line all-bronze pump with gauge ports at nozzles and with vent and drain ports. Mechanical seal with ceramic seat and carbon seal ring suitable for continuous operation at 225 deg F. Built-in overload protection. Drip-proof-type motor, maximum rating of working pressure up to 150 psi.
 - 2. Manufacturers: Bell & Gossett, Grundfos, TACO, Amtrol.
- F. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.
 - 1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 - 2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
- G. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.
- H. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- I. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- K. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- L. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
- M. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases.
 - 1. Exception: Omit concrete bases for commercial, electric, 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 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 electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend

commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

- D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- F. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- G. Fill electric, domestic-water heaters with water.
- H. Charge domestic-water compression tanks with air.
- I. Install hot water recirculating pumps in accordance with the manufacturer's recommendations and as indicated on plans. Comply with manufacturer's specific recommendations for approved installation orientation and support methods. Do not support from motor casing, or in any manner that will stress the pump/motor drive components. Installation to include gate valves on each side of pump, accessible from floor.
- J. Domestic hot water recirculation pump to "start" and "stop" with aquastat installed on return piping. Aquastat to be direct acting to close a contact on piping water temperature drop. Set for contact closure at 15 degrees F. below indicated hot water supply temperature.
- K. Electric power wiring for recirculating pumps furnished and installed by the Electrical Contractor, coordinate installation.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 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 operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

END OF SECTION 22 33 00

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this Section includes, but is not limited to:
 - 1. Inclusion of all plumbing fixtures, complete and ready for use. All fixtures, except as otherwise specified, shall be constructed of vitreous china with all visible exposed surfaces glazed.
 - 2. Providing all stops, traps, escutcheons, connections, etc., as are necessary to complete the installation of each fixture, whether such items are listed or not.
 - 3. Plumbing Trim: All finished exposed faucets, traps, connecting piping, stops, flush valves and other fixture trim shall be chromium-plated brass unless otherwise specified and shall be supported rigidly to fixtures and to walls with matching brackets at not more than 2'-0" center. All fastenings shall be chromium-plated brass or may be 302 stainless steel if of matching color and finish. Faucets shall be furnished as required. Vacuum breakers shall be provided as a part of the fixture trim wherever there is a possibility of back-siphoning.
 - 4. Fixture Stops: Shut-offs for urinal and water closet flush valves shall be an integral part of the fixture or fitting; shut-offs for all other fixtures shall be loose-key, lock-shield-type. All fixture stops shall be angle- or straight-type adapted for each particular location and shall be located immediately adjacent to the fixture. Use threaded adaptors when used in conjunction with copper tube work.
 - 5. All exposed screws or fasteners for plumbing fixtures and faucets shall be vandalproof. Contractor shall take care to coordinate this item with his suppliers prior to Shop Drawings submittal.
 - 6. Aerators, where required for sinks and lavatories shall be vandalproof

1.2 QUALITY ASSURANCE

- A. Meet the requirements of the following:
 - 1. State Plumbing Code.
 - 2. State Department of Housing, Buildings and Construction.
- B. Material Standards
 - 1. ANSI/ASME A112.19.2-90: Vitreous China Plumbing Fixtures.
 - 2. ANSI/ASME A112.19.3-87: Stainless Steel Plumbing Fixtures (Designed for Residential Use).
 - 3. ANSI/ASME A112.19.5-79: Trim for Water Closet Bowls, Tanks, and Urinals.
 - 4. ANSI/ASSE 1016-90: Performance Requirements for Thermostatic, Pressure Balancing and Combination Control Valves for Bathing Facilities.

- C. ANSI/ASSE 1025-78: Performance Requirements for Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon-Type, Residential Applications.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.
- C. LEED Submittals: Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
- D. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. For flushometer valves and electronic sensors to include in operation and maintenance manuals.
 - 2. For lavatories and faucets to include in operation and maintenance manuals.
 - a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following: Servicing and adjustments of automatic faucets.
 - 3. For sinks to include in maintenance manuals.
 - 4. For shower faucets to include in maintenance manuals.
 - 5. For wash fountains and components to include in operation and maintenance manuals.
 - 6. For drinking fountains to include in maintenance manuals.
 - 7. For remote water coolers to include in maintenance manuals.
 - 8. For pressure water coolers to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no less than one of each type.
 - 2. Waterless Urinal Trap-Seal Cartridges: Equal to 200 percent of amount of each type installed, but no fewer than 12 of each type.
 - 3. Waterless Urinal Trap-Seal Liquid: Equal to 1 gallon for each urinal installed.

4. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
5. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
6. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no less than 1 of each.

1.6 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. Faucets: 3% of installed quantity for each model installed, and not less than one of each model installed.
 2. Flush valves: 3% of installed quantity for each model installed, and not less than one of each model installed.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

- A. Acceptable Manufacturers
 1. Plumbing Faucets: Chicago Faucet, Sloan.
 2. Flush Valves: Sloan.
 3. Vitreous China Plumbing Fixtures: American Standard, Kohler, Gerber.
 4. Service Basins: Fiat, Stern and Williams, Mustee, Zurn and Creative Industries.
 5. Service Sinks: American Standard, Kohler, Gerber.
 6. Utility Sinks: Fiat, Stern and Williams, Mustee.
 7. Stainless Steel Utility Sinks: Advanced Tabco, Elkay, Just.
 8. Closet Seats: Bemis.
 9. Stainless Steel Sinks: Elkay, Just, Metcraft, and Southern Kitchens.
 10. Electric Water Coolers: Elkay, Haws, and Halsey-Taylor.
 11. Lavatory Systems: Bradley, Acorn, Intersan.
 12. Carriers: Josam, Smith, Wade, Watts, Zurn or Mifab.
- B. Plumbing Fixtures – General: Constructed or equipped with anti-siphon devices to prevent siphoning waste material into potable water supply system.
- C. Escutcheons and Plates: Conceal all holes where pipes pass through walls, floors or ceilings; use plates or escutcheons.
- D. Piping Exposed in Finished Areas (including fittings and trim): Chromium-plated or nickel-plated brass with polished bright surface.
- E. Trim for Lavatories and Sinks: Provide with renewable cartridges.
- F. Vitreous Caps: Provide for water closet bolts.

- G. Sealant: Silicone-type. See Division 07 Section "Joint Sealants".

2.2 FLOOR MOUNTED WATER CLOSETS

- A. Manufacturers subject to compliance with requirements:

1. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard and ADA.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 GPF.
 - h. Spud Location: top.
 - i. Outlet Location: bottom.
 - j. Color: To be selected by Architect.
 - k. Support:
 - 1) Standard: ASME A112.6.1M.
 - 2) Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
2. Bowl-to-Drain Connecting Fitting: ASME A112.4.3.

- B. Lever-Handle, Diaphragm Flushometer Valves:

1. Manufacturers subject to compliance with requirements,
 - a. Standard: ASSE 1037.
 - b. Minimum Pressure Rating: 125 psig.
 - c. Features: Include integral check stop and backflow-prevention device.
 - d. Material: Brass body with corrosion-resistant components.
 - e. Exposed Flushometer-Valve Finish: Chrome plated.
 - f. Panel Finish: Chrome plated or stainless steel.
 - g. Style: Exposed.
 - h. Consumption: 1.6 GPF.

- C. Solenoid-Actuator, Diaphragm Flushometer Valves:

1. Manufacturers subject to compliance with requirements:
 - a. Standard: ASSE 1037.
 - b. Minimum Pressure Rating: 125 psig.
 - c. Features: Include integral check stop and backflow-prevention device.
 - d. Material: Brass body with corrosion-resistant components.
 - e. Exposed Flushometer-Valve Finish: Chrome plated.
 - f. Panel Finish: Chrome plated or stainless steel.
 - g. Style: Exposed.
 - h. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- i. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- j. Consumption: 1.6 GPF .

D. Toilet Seat

- 1. Manufacturers: Subject to compliance with requirements:
 - a. Standard: IAPMO/ANSI Z124.5.
 - b. Material: Plastic.
 - c. Type: Commercial (Heavy duty).
 - d. Shape: Elongated rim, open front.
 - e. Hinge: Self-sustaining, check.
 - f. Hinge Material: Non-corroding metal.
 - g. Seat Cover: Not required.
 - h. Color: To be selected by Architect.

2.3 WALL-HUNG URINALS

A. Manufacturers subject to compliance with requirements:

- 1. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
- 2. Material: Vitreous china.
- 3. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
- 4. Water Consumption: Water saving.
- 5. Spud Location: top.
- 6. Outlet Location: back.
- 7. Color: To be selected by Architect.
- 8. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

B. Lever-Handle, Diaphragm Flushometer Valves:

- 1. Manufacturers subject to compliance with requirements,
 - a. Standard: ASSE 1037.
 - b. Minimum Pressure Rating: 125 psig.
 - c. Features: Include integral check stop and backflow-prevention device.
 - d. Material: Brass body with corrosion-resistant components.
 - e. Exposed Flushometer-Valve Finish: Chrome plated.
 - f. Panel Finish: Chrome plated or stainless steel.
 - g. Style: Exposed.
 - h. Consumption: 0.5 GPF.

C. Solenoid-Actuator, Diaphragm Flushometer Valves:

- 1. Manufacturers subject to compliance with requirements:
 - a. Standard: ASSE 1037.
 - b. Minimum Pressure Rating: 125 psig.
 - c. Features: Include integral check stop and backflow-prevention device.
 - d. Material: Brass body with corrosion-resistant components.
 - e. Exposed Flushometer-Valve Finish: Chrome plated.
 - f. Panel Finish: Chrome plated or stainless steel.
 - g. Style: Exposed.

- h. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- i. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- j. Consumption: 0.5 GPF.

2.4 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Round, self-rimming, vitreous china, counter mounted.
 - 1. Manufacturers: Subject to compliance with requirements:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Faucet-Hole Punching: One hole.
 - d. Faucet-Hole Location: Top.
 - e. Color: To be selected by Architect.
 - f. Mounting Material: Sealant
 - g. Faucet: Automatic.
- B. Faucets
 - 1. General: NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water
 - 2. Lavatory Faucets: Automatically Operated
 - a. Automatic-type, hard-wired, electronic-sensor-operated, solid-brass lead free valve.
 - b. Manufacturers: Subject to compliance with requirements:
 - 1) Standard: ASME A112.18.1/CSA B125.1.
 - 2) General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 - 3) Body Type: Single hole.
 - 4) Body Material: Commercial, solid brass.
 - 5) Finish: Polished chrome plate.
 - 6) Maximum Flow Rate: 0.5 GPM.
 - 7) Mounting Type: Deck, exposed.
 - 8) Spout: Rigid type.
 - 9) Spout Outlet: Aerator
- C. Supply Fittings
 - 1. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water
 - 2. Standard: ASME A112.18.1/CSA B125.1.
 - 3. 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.
 - 4. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

5. Operation: Loose key
6. Risers: ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

D. Waste Fittings

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with offset and straight tailpiece.
3. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17 gauge seamless brass tube to wall, cleanout plug and chrome-plated brass or steel wall flange.

2.5 MOP SINKS

A. Mop Sinks: Terrazzo, floor mounted.

1. Manufacturers: Subject to compliance with requirements:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Square.
 - c. Nominal Size: 24 by 24 inches.
 - d. Height: 12 inches.
 - e. Rim Guard: On all top surfaces.
 - f. Drain: Grid.

B. Faucets

1. General: NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water
2. Service Sink Faucets: Manual type.
3. Standard: ASME A112.18.1/CSA B125.1.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and coordinate outlet with spout and sink receptor.
5. Body Type: Widespread.
6. Body Material: Commercial, solid brass.
7. Maximum Flow Rate: 2.2 GPM.
8. Handle(s): Lever.
9. Mounting Type: 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.

2.6 STAINLESS STEEL SINKS

A. Manufacturers: Subject to compliance with requirements:

1. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
2. Type: Top mount, basin with radius corners, deck for faucet, and fully undercoated to dampen sound and prevent condensation.
3. Number of Compartments: One.
4. Metal Thickness: 18 gauge
5. Drain: Nickel plated brass body with grid strainer, polished finish.
6. Garbage Disposal: Continuous feed, galvanized steel grinding elements with two stainless steel 360 degree swivel lugs, dishwasher connection.

B. Sink Faucets: Manually Operated

1. Manual-type, single-control mixing solid-brass lead free valve.
2. Manufacturers: Subject to compliance with requirements:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 - c. Body Type: Centerset.
 - d. Body Material: Commercial, solid brass.
 - e. Finish: Polished chrome plate.
 - f. Maximum Flow Rate: 1.5 GPM.
 - g. Mounting Type: Deck, exposed.
 - h. Valve Handle(s): Lever.
 - i. Spout: Rigid, Swing, gooseneck type.
 - j. Spout Outlet: Aerator.

C. Supply Fittings

1. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. 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.
4. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
5. Operation: Loose key
6. Risers: ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

D. Waste Fittings

1. Standard: ASME A112.18.2/CSA B125.2.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17 gauge seamless brass tube to wall, cleanout plug and chrome-plated brass or steel wall flange.

2.7 ELECTRIC WATER COOLERS

A. Manufacturers: Subject to compliance with requirement:

1. Comply with NSF 61.
2. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
3. Cabinet: Single or Bi-level with two attached cabinets vinyl-covered steel with stainless-steel top.
4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
5. Filter: One or more water filters complying for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
6. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

- 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.
- 7. Capacities and Characteristics:
 - a. Cooled Water: 8 GPH.
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics: 120 VAC, Single phase, 60 HZ
- 8. Support: ASME A112.6.1M, Type I water-cooler carrier.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Water-Closet
 - 1. Installation:
 - a. Install level and plumb according to roughing-in drawings.
 - b. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
 - c. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
 - 2. Support Installation:
 - a. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
 - b. Use carrier supports with waste-fitting assembly and seal.
 - c. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
 - d. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
 - 3. Flushometer-Valve Installation:
 - a. Install flushometer-valve, water-supply fitting on each supply to each water closet.
 - b. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 - c. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
 - d. Install actuators in locations that are easy for people with disabilities to reach.

- e. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
- 4. Install toilet seats on water closets.

B. Urinal

- 1. Installation:
 - a. Install urinals level and plumb according to roughing-in drawings.
 - b. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
 - c. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
 - d. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
 - e. Install trap-seal liquid in waterless urinals.
- 2. Support Installation:
 - a. Install supports, affixed to building substrate, for wall-hung urinals.
 - b. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
 - c. Use carriers without waste fitting for urinals with tubular waste piping.
 - d. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
- 3. Flushometer-Valve Installation:
 - a. Install flushometer-valve water-supply fitting on each supply to each urinal.
 - b. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 - c. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
 - d. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

C. Lavatories

- 1. Install lavatories level and plumb according to roughing-in drawings.
- 2. Install supports, affixed to building substrate, for wall-mounted lavatories.
 - a. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- 3. 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 220518 "Escutcheons for Plumbing Piping."
- 4. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- 5. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

D. Sinks

- 1. Install sinks level and plumb according to roughing-in drawings.
- 2. Install supports, affixed to building substrate, for wall-hung sinks.
 - a. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- 3. Set floor-mounted sinks in leveling bed of cement grout.
- 4. Install water-supply piping with stop on each supply to each sink faucet.

- a. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 - b. Install stops in locations where they can be easily reached for operation.
 5. 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 220518 "Escutcheons for Plumbing Piping."
 6. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."
- E. Electric Water Coolers
1. Install electric water cooler level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
 2. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
 3. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
 4. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 5. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
 6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants." Wall Flange and Escutcheon Installation:
1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Joint Sealing:
1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 2. Match sealant color to water-closet color.
 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixture with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to fixtures, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust fixture and controls. Replace damaged and malfunctioning fixture
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean fixture and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00

SECTION 23 00 00

HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general requirements applicable to all HVAC work.
- B. Provide complete and fully operational HVAC systems controlled as indicated.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, spaces above ceilings, unexcavated spaces, crawlspace, 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 chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: As indicated in other Division 23 Sections.
 - 2. Shop Drawings: As indicated in other Division 23 Sections.
- B. Informational Submittals:
 - 1. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Building roofs, walls, and floors.

- b. Building structural components to which equipment, piping, ductwork, cables, and conduit will be attached.
- c. Suspended ceiling components.
- d. HVAC equipment, piping, ductwork, and controls.
- e. Size and location of access doors and panels installed in walls and inaccessible ceilings for products installed behind walls and requiring access.
- f. Items penetrating finished ceiling including the following:
 - 1) Luminaires.
 - 2) Air outlets and inlets.
 - 3) Ceiling-mounted devices including speakers, sensors, and WI-FI antennae.
 - 4) Sprinklers.
 - 5) Service access panels.

C. Closeout Submittals:

- 1. Operation and Maintenance Data: For HVAC systems and equipment to include in emergency, operation, and maintenance manuals. Provide data in pdf format on CD, DVD, or USB media.
- 2. Warranty documentation:
- 3. Record documentation:
- 4. Testing, adjusting and balancing report.
- 5. Start reports for all equipment.
- 6. Field reports, including ductwork leakage testing and piping pressure testing.
- 7. Valve tag charts.
- 8. Subcontractor contact list including name, phone number and email contact information.
- 9. Maintenance Items: Provide items specified in other Division 23 Sections packaged with protective covering for storage and identified with labels describing contents.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Where feasible, arrange for product delivery when construction has progressed enough to allow the products to be installed in their final locations. If lieu of the above, store products protected from weather and physical damage.
- 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 into pipe.
- C. Do not allow any materials or equipment to be stored in standing water or exposed to the elements.
- D. Handle products carefully to prevent damage. Do not install damaged items; replace them with new items. If approved by the Engineer, items with minor damage may be repaired and installed.

1.5 COORDINATION

- A. Arrange for pipe spaces, chases, and openings in building structure during progress of construction, to allow for HVAC installation.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.
- D. Existing Utilities: Do not interrupt utilities serving facilities occupied or partially occupied unless specifically allowed under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Owner at least seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions and method of interruptions in detail.
 - 2. Do not proceed with proposed utility interruptions without Owner's permission.
 - 3. Utilization of the permanently installed HVAC systems to condition or pressurize the construction area is not allowed without prior specific written authorization from the Owner listing which equipment may be operated under what limiting conditions. Provide written agreement to compensate the Owner for utility usage.
- E. New Equipment:
 - 1. All equipment items are to remain disabled and off unless TAB personnel are on-site actively testing the equipment.
 - 2. Utilization of the permanently installed HVAC systems to condition or pressurize the construction area is not allowed without prior specific written authorization from the Owner listing which equipment may be operated under what limiting conditions. Provide written agreement to compensate the Owner for utility usage.
- F. Coordinate new installations with existing installations which will remain in place and either be reutilized or be abandoned in place. Provide transitions and fittings in ductwork and piping as well as extra lengths of ductwork and piping as required to route around existing installations. Illustrate all such ductwork fittings on the sheet metal shop drawing submittal. Existing installations include plumbing, piping, electrical and other building system components including, but not limited to, roof drain piping, sanitary piping, plumbing piping, fire protection piping and heads, heating and cooling water piping, condensate drains, steam and condensate piping, conduit, cable tray, electrical pull boxes, projectors, booms, etc.
- G. Provide temporary connections to maintain existing systems in service during construction.
- H. Provide the Owner a schedule prior to the start of demolition with a phased selected demolition identified by system and by floor. Identify required outages on the schedule and any temporary measures required to maintain existing systems in service.

- I. Coordinate HVAC demolition with all aspects of demolition and temporary construction (including dust barriers) by other trades.
- J. The Drawings indicate the general arrangement and scope of the systems and shall be followed insofar as possible. If deviations from the layout are necessitated by field conditions, submit detailed layouts of the proposed departures in writing to the Engineer for approval before proceeding with the work.
- K. The Drawings are schematic and are not intended to show every vertical and horizontal offset that may be necessary to complete the system or clear obstructions or the work of the other contractors. Contractors shall anticipate during bidding that additional offsets may be required and include same in their proposals.
- L. The Drawings and Specifications are complementary. Items appearing in the Specifications may not be indicated on the Drawings or vice-versa, but all shall be considered as part of the Contract and must be executed by the Contractor the same as though indicated by both. Clarify conflicting statements with the Engineer prior to submitting a bid.
- M. Measurements: Make your own measurements on site and be responsible for correct sizes. Coordinate this work with all other branches and trades in such a manner as to cause a minimum of conflict or delay. Coordinate your work in advance with all other trades and report immediately difficulties anticipated; propose solutions to resolve potential difficulties.
- N. Clearances: Install items to maintain maximum headroom and clearance around equipment. When space or headroom appear inadequate, notify the Engineer prior to proceeding with the installation. No claims for additional compensation due to failure on the part of the Contractor or his subcontractor to comply with this requirement will be approved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the listed manufacturers. Where a specific manufacturer is listed on the Drawings, consider it as the Basis-of-Design.

2.2 ELECTRICAL REQUIREMENTS

- A. Electrical Characteristics for HVAC Equipment: Equipment with higher electrical power requirements may be furnished provided that such proposed equipment is approved in writing and that connecting electrical supply, wiring, overcurrent protection devices, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

2.3 GROUT

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine work area and rough-in work before beginning installation.
- B. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Plan Work beforehand.
- B. Request explanation from the Engineer if the intent of the Drawings or Specifications is not clear.

3.3 INSTALLATION

- A. Install mechanical items in accordance with the Specifications and manufacturer's installation instructions.

3.4 CONCRETE BASES

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

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi 28-day compressive-strength concrete and reinforcement.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Metal channel (strut) products in accordance with Metal Framing Manufacturers Association standards may be used for metal framing and anchorages.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor HVAC 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 or weakening wood members.
- C. Attach to substrates as required to support applied loads.

3.7 GROUTING

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

3.8 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom if specific mounting heights are not indicated.

- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Maintain manufacturer's recommended service clearances. Maintain NFPA 70 required clearances to electrical components.
- D. Connect equipment for ease of disconnecting with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment to allow space for piping installed at required slope.

3.9 CLEANING AND RESTORATION

- A. Repair damage resulting from the execution of the Work.
- B. Leave the work area in broom clean condition or better at the end of each day.
- C. Thoroughly clean the work area at the completion of construction.

3.10 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect mechanical equipment components, assemblies, and installations, including connections.
- B. Non-Conforming Work: Items will be considered defective if they do not pass tests and inspections.
- C. Reports: Prepare test and inspection reports for informational submittals.

3.11 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.12 STARTUP

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to startup mechanical equipment according to manufacturer's instructions.

3.13 DEMONSTRATION

- A. Engage factory-authorized service representatives to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Video record the training sessions and provide electronic copy to Owner.

END OF SECTION 23 00 00

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Rotor: Random-wound, squirrel cage.
- E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating.
- G. Insulation: Class F.
- H. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Grounding: Maintenance free, conductive micro-fiber shaft-grounding ring with a minimum of two rows of circumferential micro fibers to discharge shaft voltages away from the bearings to ground.
 - a. Motors 100 HP or Less: One shaft grounding ring installed either on the drive end or non-drive end.
 - b. Motors More Than 100 HP: Insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor.

- c. All Motors: Bonded from motor foot to system ground with high-frequency ground strap of flat braided, tinned copper with terminations to accommodate motor foot and system ground connections.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Motor: Brushless permanent magnet DC motor.
- B. Control: Integral control module to convert AC power to DC power and to generate three-phase signal to direct motor speed. Motor speed adjustment through 0-10 V DC input.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

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SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers, saddles, and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

1.2 DEFINITIONS

- A. MSS:** Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology:** As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 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.
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.

1.4 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.
2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - a. Trapeze pipe hangers.
 - b. Metal framing systems.
 - c. Fiberglass strut systems.
 - d. Pipe stands.
 - e. Equipment supports.

B. 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.

C. Informational Submittals:

1. Welding certificates.

D. Closeout Submittals:

1. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. SMACNA.
- D. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.
- E. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. B-line Systems, Inc; a division of Cooper Industries.
 - 2. Carpenter & Paterson, Inc.
 - 3. ERICO/Michigan Hanger Co.
 - 4. Globe Pipe Hanger Products, Inc.
 - 5. Grinnell Corp.
 - 6. National Pipe Hanger Corporation.
 - 7. PHD Manufacturing, Inc.
- B. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized 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 or stainless steel.
- C. Saddles
 - 1. Material Galvanized Steel, 180-degree shape, each saddle marked with insulation O.D. Standard manufacturers gauge per insulated pipe size.
- D. 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 or stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufactured Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Unistrut Corporation; Atkore Int.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. Thomas & Betts Corporation.
 - e. 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.
7. Metallic Coating: Galvanized by electroplating or hot-dipping.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Anvil International; a subsidiary of Mueller Water Products Inc.
 - b. ERICO International Corporation.
 - c. PHD Manufacturing, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with 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.

2.5 FIBERGLASS STRUT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. Power-Strut; Atkore Int.
 2. Champion Fiberglass, Inc.
 3. Cooper B-Line, Inc.
 4. SEASAFE, INC.; a Gibraltar Industries Company.
- B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
 1. Channels: Continuous slotted fiberglass channel with inturned lips.
 2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. Carpenter & Paterson, Inc.
 2. ERICO International Corporation.
 3. National Pipe Hanger Corporation.
 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig, or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 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 V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel 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 or stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 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-Mounted-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.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 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, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-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.
 - I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
 - J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
 - K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - L. Install lateral bracing with pipe hangers and supports to prevent swaying.
 - M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
 - N. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
 - O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
 - P. 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 outside diameter of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

- b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers, fiberglass pipe hangers, fiberglass strut systems, and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. 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.

5. 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.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 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.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. 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 allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

END OF SECTION 23 05 29

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SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.
2. Samples: For color, letter style, and graphic representation required for each identification material and device.
3. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
4. Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass: 0.032-inch, stainless steel: 0.025-inch, aluminum: 0.032-inch, or anodized aluminum: 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-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-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- 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.

3.3 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 23 05 53

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing air systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Certified TAB reports.
- B. Informational Submittals:
 - 1. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
 - 2. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
 - 3. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
 - 2. TAB Technician: Employee of the TAB contractor and certified by AABC or NEBB as a TAB technician.
- B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard AABC or NEBB TAB forms.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 COORDINATION

A. Notice: Provide at least seven days' notice before each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.6 HVAC CONTRACTOR RESPONSIBILITIES

A. Provide TAB agency one complete set of contract documents, change orders, and approved submittals in digital pdf format.

B. Control contractor shall provide required BAS hardware, software, personnel, and assistance to TAB agency as required for TAB agency to balance the systems. Control contractor shall also provide trending reports as needed to demonstrate that systems are complete.

C. Coordinate meetings and assistance from suppliers and contractors as required by TAB agency.

D. Provide additional valves, dampers, sheaves and belts as required by TAB agency.

E. Provide access to all dampers, valves, test ports, nameplates, and other appurtenances as required by TAB agency.

F. Remove and replace or repair insulation as needed to provide access for the TAB work.

G. Have the HVAC systems at complete operational readiness before TAB begins.

H. Promptly correct deficiencies identified during TAB.

I. Maintain a construction schedule that allows the TAB agency to complete work prior to occupancy.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC systems 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 plenums 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 might cause reduced capacities.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment under actual installed conditions. Use tables and charts in AMCA 201, "Fans and Systems" or in SMACNA "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, clean filters are installed, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, verifying that they are accessible and that their controls are connected, configured by the control contractor, and functioning.
- K. Examine all equipment items to verify correct piping arrangements.
- L. Examine heat-transfer coils for correct piping connections and for clean and properly-spaced fins.

- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes:

- 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 each equipment item.

- B. Complete system-readiness checks and prepare reports. Verify the following:

- 1. General:

- a. Electrical power wiring is complete.
- b. Control systems are operational.
- c. Access is provided to balancing and control devices.
- d. Variable frequency drive start-up procedures are complete.
- e. Safety devices are operational and indicating normal status.

- 2. Air Side:

- a. Ductwork is complete with air terminals installed.
- b. Balance, fire, and smoke dampers are open and operational.
- c. Control dampers are in their normal (fail) positions.
- d. Equipment and duct access doors are securely closed.
- e. Clean filters are installed.
- f. Fans are operating and rotating in correct directions.
- g. Fan vibration levels are within tolerance limits.
- h. Building envelope is complete, and exterior windows and doors are closed.

- 3. Hydronics:

- a. Piping is complete with all terminal units installed.
- b. Systems are flushed, filled, and purged of free air.
- c. Strainers are clean, and startup strainer screens are removed.
- d. Water treatment is complete.
- e. Isolation and balance valves are open and operational. Drain valves are closed.
- f. Control valves are in their normal (fail) positions.
- g. Pumps are operating and rotating in correct directions.
- h. Pump vibration levels are within tolerance limits.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC "National Standards for Total System Balance" or NEBB

"Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" 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, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 - 2. Install new insulation where insulation is removed for TAB to match removed materials. Restore insulation, coverings, vapor barrier, and finish.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control devices, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of system "as-built" duct layouts with all components identified.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check condensate drains for proper connections and function.
- G. Check for proper sealing of air-handling-unit components.

3.5 PROCEDURES FOR CONSTANT-VOLUME AND VARIABLE-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 as follows:
 - a. Set outdoor air, return air, and relief air dampers for proper positions that simulate minimum outdoor air conditions.
 - b. Where conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where conditions are not suitable for duct Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Where sufficient space is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow. Measure fan static pressures as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the discharge flexible connection.
 - c. Measure inlet static pressure of single-inlet fan at the fan inlet or through the inlet flexible connection.
 - d. Measure inlet static pressure of double-inlet fan through the wall of the plenum that houses the fan or through the inlet flexible connections.
 3. Measure static pressure across each component that makes up the air-handling unit, rooftop unit, or other air-handling equipment. Report the cleanliness status of filters and the time static pressures are measured. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 4. Adjust fan speed higher or lower than indicated speed as needed 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 will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for ducts to indicated airflows within specified tolerances.
1. Measure airflows of branch ducts.
 2. Adjust branch duct balance dampers for specified airflows.
 3. Re-measure each branch duct after all have been adjusted.
- C. Adjust air outlets and inlets for each space to indicated airflows.
1. Adjust each outlet in same room or space to indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
 3. Measure airflows at all inlets and outlets.
 4. Adjust each inlet and outlet for specified airflow.
 5. Re-measure each inlet and outlet after all have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm minimum outdoor air, return air, and relief air flow rates are within design tolerances. Readjust as necessary.
 2. Re-measure and confirm total airflow is within design tolerance.
 3. Re-measure all final fan operating data. Include fan speeds, motor voltages, motor amperages, and static profiles.
 4. Mark all final settings.

5. Test system in economizer mode. Verify proper operation; adjust if necessary. Measure and record all operating data.
6. Record final performance data.

3.6 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Other Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.

3.7 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into a separate section for each tested and balanced system. Provide a final report that is a complete record of the HVAC system performance, including conditions of operation, any outstanding items, and any deviations found during the testing and balancing process. The final report is to provide a reference of actual operating conditions for the owner and operations personnel. All measurements and test results that appear in the report must be made on site and dated by the responsible technician or test and balance engineer.
- B. As a minimum the report shall include the following information:
 1. Title page, including:
 - a. TAB company name, address, and telephone number.
 - b. Project name, client, identification number, and location.
 - c. Project architectural firm, address, and telephone number.
 - d. Project HVAC engineering firm, address, and telephone number.
 - e. Project HVAC contracting firm, address, and telephone number.
 - f. TAB certification statement.
 - g. Test and balance engineer name, signature, and certification number.
 - h. Report date.
 2. Table of contents.
 3. TAB national performance guarantee.
 4. Report summary, including:
 - a. List of items that do not meet specified tolerances.
 - b. Information that may be considered in resolving deficiencies.
 5. Instrument list, including:
 - a. Type.
 - b. Manufacturer.
 - c. Model.
 - d. Serial number.
 - e. Calibration date.

- C. TAB test data for all systems included in the Work.

3.8 INSPECTIONS

- A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure room temperature at each thermostat or temperature sensor. Compare the reading to the set point.
 - c. Verify that balancing devices are marked with final balance positions.
 - d. Note deviations from the Contract Documents in the final report.

- B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner's Representative.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Owner's Representative.
3. Owner's Representative shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to 10 percent of the total measurements recorded.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and adjust. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's payment.

- D. Prepare test and inspection reports.

END OF SECTION 23 05 93

SECTION 23 07 13

HVAC DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes duct insulation and appurtenances.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 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.
- B. Protection: Do not permit mineral fiber insulation to get wet. Mineral fiber insulation that is or has been wet shall be removed from the project site.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.

- B. Coordinate clearance requirements with duct Installer for duct insulation application. Establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 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.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Properties:
 - a. Maximum Operating Temperature: 180 deg F.
 - b. Minimum Operating Temperature: -70 deg F.
 - c. Maximum Thermal Conductivity at 75 deg F Mean Temperature: Thickness 1 Inch or Less: 0.245 Btu-in/hr-ft²-deg F.
 - d. Maximum Water Vapor Permeability Thickness 1 Inch or Less: 0.05 perm-inches.
 - e. Maximum Water Absorption by Volume: 0.2%.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin in a flexible blanket. Comply with ASTM C 553, Type II and ASTM C 1290,

Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Atmosphere Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR Duct Wrap FRK.
2. Properties:
 - a. Maximum Operating Temperature: 250 deg F.
 - b. Maximum Compressed Thermal Conductivity at 75 deg F Mean Temperature:
 - 1) Density 0.75 PCF: 0.29 Btu-in/hr-ft²-deg F.
 - 2) Density 1.0 PCF: 0.27 Btu-in/hr-ft²-deg F.
 - 3) Density 1.5 PCF: 0.24 Btu-in/hr-ft²-deg F.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. For indoor applications, adhesives shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 4. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 2. Service Temperature Range: 0 to 180 deg F.
 3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 4. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 4. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: 60 percent by volume and 66 percent by weight.
 4. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 2. Service Temperature Range: 0 to plus 180 deg F.
 3. Color: White.

2.5 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
- B. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

PART 3 - EXECUTION

3.1 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.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation in accordance with manufacturers' instructions.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- C. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system.
- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Keep insulation materials dry during application and finishing. Mineral fiber insulation that is or has been wet shall be removed from the job site.
- 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 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.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Floor Penetrations:
 - 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Seal penetrations through fire-rated assemblies.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket or Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to all surfaces of ducts, fittings, and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches on center each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with outward-clinching staples, 1 inch on center. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches on center.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. For board insulation, groove and score insulation to fit to outside and inside radii of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on

alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.

3.7 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in painting specifications.
 - 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.

3.8 DUCT INSULATION THERMAL RESISTANCE (R VALUE) SCHEDULE

- A. Space types are as defined in ASHRAE 90.1-2019.
 - 1. Exterior ducts are in unenclosed spaces and include those outdoors, in outdoor air plenums, in attics above insulated ceilings, in parking garages, or in crawl spaces.
 - 2. Ducts in unconditioned spaces include those in enclosed indoor spaces that are not heated, cooled, or semiheated.
 - 3. Buried ducts are those enclosed in earth or concrete below ground.
 - 4. Ducts in indirectly conditioned spaces including those in enclosed return air plenums, spaces above ceilings, and non-cooled mechanical or electrical rooms.
 - 5. Ducts in conditioned spaces include those in enclosed spaces that have:
 - a. Equipment sensible cooling capacities at least 3.4 Btu/hr/sf, or
 - b. Equipment heating capacities at least those indicated in ASHRAE 90.1 Table 3.2.
 - 6. Ducts in semiheated spaces include those in enclosed spaces that have equipment heating capacities at least 3.4 Btu/hr/sf but less than those indicated in ASHRAE 90.1 Table 3.2.
- B. Supply Air, Return Air, or Mixed Air Ducts:
 - 1. Exterior Ducts:
 - a. Climate Zones 0, 1, 2, 3, 4: R-8.
 - b. Watertight external jacket completely enclosing external duct insulation on ducts installed outdoors (other than preinsulated ducts).
 - 2. Ducts in Unconditioned Spaces, in Semiheated Spaces, or Buried:

- a. Climate Zones 0, 1, 2, 3, 4: R-6.
- 3. Ducts in Indirectly Conditioned Spaces:
 - a. Climate Zones 0, 1, 2, 3, 4: R-2.
 - b. Return Air Ducts: No insulation required.
- 4. Ducts in Conditioned Spaces:
 - a. Climate Zones 0, 1, 2, 3, 4: R-2.
 - b. Supply Air Ducts: Double-wall ducts; no additional insulation required.
 - c. Return Ducts: No insulation required.
- C. Relief Air Ducts: No insulation required.
- D. Exhaust Air Ducts (Other Than Ducts for High-Temperature or Grease-Laden Exhaust):
 - 1. Ducts in Unconditioned Spaces, in Semiheated Spaces, or Buried: No insulation required unless indicated otherwise.
 - 2. Ducts in Indirectly Conditioned Spaces: No insulation required.
 - 3. Ducts in Conditioned Spaces: No insulation required.

3.9 DUCT INSULATION THICKNESS SCHEDULE

- A. R-2:
 - 1. Flexible Elastomeric: 1/2 inch thick.
 - 2. Mineral-Fiber Blanket: 1-1/2 inch thick and 0.75-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Blanket: 1-1/2 inch thick and 1-lb/cu. ft. nominal density.
 - 4. Mineral-Fiber Blanket: 1 inch thick and 1.5-lb/cu. ft. nominal density.
- B. R-6:
 - 1. Flexible Elastomeric: 2 inches thick.
 - 2. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Blanket: 2 inches thick and 1-lb/cu. ft. nominal density.
 - 4. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
- C. R-8:
 - 1. Flexible Elastomeric: 2-1/2 inches thick (ducts located outdoors only).
 - 2. Mineral-Fiber Blanket: 2-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Blanket: 2-1/2 inches thick and 1-lb/cu. ft. nominal density.
 - 4. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- D. R-12:
 - 1. Flexible Elastomeric: 3-1/2 inches thick (ducts located outdoors only).
 - 2. Mineral-Fiber Blanket: 3-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Blanket: 3-1/2 inches thick and 1-lb/cu. ft. nominal density.

4. Mineral-Fiber Blanket: 3 inches thick and 1.5-lb/cu. ft. nominal density.

E. Additional Requirements or Restrictions:

1. Flexible elastomeric insulation in thicknesses greater than 2 inches is not permitted indoors.
2. Mineral fiber insulation on ducts located outdoors must have a waterproof PVC or metal jacket.

END OF SECTION 23 07 13

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating HVAC piping systems.

1.2 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 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.
- B. Protection: Do not permit mineral fiber or calcium silicate insulation to get wet. Mineral fiber or calcium silicate insulation that is or has been wet shall be removed from the project site.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.

- B. Coordinate clearance requirements with piping Installer for piping insulation application.

1.6 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.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Properties:
 - a. Maximum Operating Temperature: 180 deg F.
 - b. Minimum Operating Temperature: -70 deg F.
 - c. Maximum Thermal Conductivity at 75 deg F Mean Temperature: Thickness 1 Inch or Less: 0.245 Btu-in/hr-ft²-deg F.
 - d. Maximum Water Vapor Permeability Thickness 1 Inch or Less: 0.05 perm-inches.
 - e. Maximum Water Absorption by Volume: 0.2%.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 2. Service Temperature Range: 0 to 180 deg F.
 - 3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 4. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 - 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 4. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: 60 percent by volume and 66 percent by weight.
 - 4. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Color: White.

2.5 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. All-Service Jacket (ASJ): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.
 - 2. All-Service Jacket – Self-Sealing Lap (ASJ-SSL): ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Maximum water vapor permeance 0.02 perms.
 - 3. Foil-Scrim Kraft (FSK) Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Maximum water vapor permeance 0.02 perms.

2.7 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. Adhesive as recommended by jacket material manufacturer.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Johns Manville; Ceel-Co or Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Color: White unless indicated otherwise.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
- C. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
- D. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
- E. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

PART 3 - EXECUTION

3.1 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.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with epoxy primer 5 mils thick and epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. 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 with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation in accordance with manufacturers' instructions.
- B. 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.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system.
- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing. Mineral fiber or calcium silicate insulation that is or has been wet shall be removed from the job site.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches on center.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.
 - 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.
- N. Cut insulation in a manner to avoid compressing insulation to less than 75 percent of its nominal thickness.
- O. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- Q. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in firestopping section.
- D. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in firestopping section.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is more. 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 more. 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 more.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches on center 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-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 4. Jacket can be wrapped along length of roll with 2-inch-overlap seal. Use adhesive on the lap seal. Visually inspect lap seal for "fish mouthing," 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.

3.8 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.
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 indicated. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Condensate or Equipment Drain Water Below 60 Deg F, or Makeup Water:

- 1. NPS 1-1/4 or Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1/2 inch thick.
- 2. NPS 1-1/2 or Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.

B. Refrigerant Suction:

- 1. NPS 3/4 or Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
- 2. NPS 1 to NPS 6: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
- 3. NPS 8 or Larger: Insulation shall be the following:
 - a. Flexible Elastomeric: 1-1/2 inches thick.

C. Refrigerant Hot-Gas:

- 1. NPS 1-1/4 or Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
- 2. NPS 1-1/2 or Larger: Insulation shall be the following:
 - a. Flexible Elastomeric: 1-1/2 inches thick.

3.10 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction:

- 1. NPS 3/4 or Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

2. NPS 1 to NPS 6: Insulation shall be the following:

a. Flexible Elastomeric: 1-1/2 inches thick.

3. NPS 8 or Larger: Insulation shall be the following:

a. Flexible Elastomeric: 2-1/2 inches thick.

B. Refrigerant Hot-Gas:

1. NPS 1-1/4 or Smaller: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

2. NPS 1-1/2 or Larger: Insulation shall be the following:

a. Flexible Elastomeric: 2-1/2 inches thick.

3.11 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: None.

D. Piping, Exposed:

1. PVC, Color-Coded by System: 20 mils thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. PVC, Color-Coded by System: 30 mils thick.

D. Piping, Exposed:

1. PVC: 30 mils thick.

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SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.2 DEFINITIONS

- A. ASC: Application Specific Controller
- B. ATC: Automatic Temperature Control
- C. BAS: Building Automation System
- D. BC: Building Controller
- E. BLCN: Building Level Communication Network
- F. CAV: Constant Air Volume
- G. CPC: Custom Programmable Controller
- H. DDC: Direct Digital Control
- I. ELCN: Enterprise Level Communication Network
- J. EMS: Energy Management System
- K. HOA: Hand-Off-Auto
- L. I/O: Input/Output
- M. MS/TP: Master Slave/Token Passing
- N. OWS: Operator Workstation
- O. PC: Personal Computer
- P. PICCV: Pressure Independent Characterized Control Valve
- Q. PID: Proportional plus Integral plus Derivative

- R. RTD: Resistance Temperature Detector
- S. SNVT: Standard Network Variable Type (for LonMark® controllers)
- T. VAV: Variable Air Volume

1.3 SCOPE

- A. Provide all necessary hardware, software and labor (design, programming, start-up, validation, acceptance, technical support, etc.) to provide a complete Building Automation System (BAS) to include all Automatic Temperature Controls (ATC) and Energy Management System (EMS) functions as specified herein and shown on the associated project drawings.
- B. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate the ANSI/ASHRAE Standard 135-2001 (BACnet) and/or ANSI/EIA Standard 709.1-A-1999 (LonWorks®) communications protocols in an open, interoperable system.
- C. The system shall be an electronic/electric system utilizing direct digital controllers (DDC) for all control processing. All sensors shall be electronic and all actuation devices shall be electronic unless indicated otherwise.

1.4 GENERAL SYSTEM DESCRIPTION

- A. The BAS shall consist of central Servers and Routers, an Operator Workstation to provide access to the graphical operator interface software, stand-alone Direct Digital Control (DDC) panels, and associated sensors and controlled devices. DDC panels shall include Building Controllers (BC), Custom Programmable Controllers (CPC) and Application Specific Controllers (ASC). A portable Operator's Terminal (laptop computer) shall also be provided for system access. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of workstations, DDC panels, sensors, actuators, etc.
- B. The BAS shall be a complete system designed for use on Intranets and the Internet. Servers and building controllers (BC) shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure within the facility. The Contractor shall be responsible for coordination with the Owner's IT staff to ensure that the BAS will perform in the Owner's environment without disruption to any other activities taking place on the infrastructure.
- C. The system architectural design shall utilize a multi-tier communications network as specified herein.
- D. The BAS specified herein shall be capable of integrating multiple building functions including equipment supervision and control of all field I/O points and software points, alarm management, energy management, historical data collection and archiving, data storage, report generation and graphics interaction.

- E. The system architectural design shall eliminate dependence upon any single device for all alarm reporting and/or control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- F. The BAS shall interface to various building systems and equipment as specified herein.
- G. Each controlled system shall have its own stand-alone DDC panel. Controllers shall not be shared across multiple controlled systems, nor shall controlled systems be split across multiple controllers. Where point counts exceed the limits of a controller, provide auxiliary input/output expansion hardware such that there is a single processor for each equipment item.
 - 1. For large systems, the active control points and control programming shall reside in one controller, while "monitor-only" points may reside in another separate single controller.
 - 2. If there are still too many active control points for the I/O capacity of a single controller, then all programming shall reside in a single controller and a second controller shall be utilized as a remote I/O board. In this scenario, sanity checking shall be required for the remote points, and the system shall shut down and alarm upon loss of communications or other invalid data from the remote controller.
- H. Provide a minimum of 20% spare Input/Output (I/O) control point capacity at each DDC panel associated with a major system (i.e. boilers, chillers, air handlers). Spare points shall include a minimum of one analog input and one analog output point, one binary input and one binary output. Universal input/output points may also be used.
 - 1. Spare Input/Output control points shall be capable of being connected to field control/sensing devices without requiring any additional DDC hardware, to be rendered functional.

1.5 WORK INCLUDED

- A. All necessary materials (including hardware and software) and labor (including design, programming, installation, start-up, validation and acceptance, training, technical support etc.) to provide a complete Building Automation System (BAS) as specified herein and shown on the associated project drawings.
- B. All wiring (including sensing and control, signal, data transmission, temperature/pressure safeties, and power) except where otherwise specified, necessary for the installation of the BAS. This shall include the costs to have a qualified electrical contractor install 120 volt control power to the BAS control cabinets throughout the facility, as well as the application specific controllers and any miscellaneous power requirements. The BAS Contractor shall coordinate quantities and locations of services with the Electrical Contractor. Final connections to be made by the BAS Subcontractor.
- C. Installation of all BAS components, except where otherwise specified.
- D. Interfacing of the BAS to various building systems and equipment. The BAS shall communicate to the various systems through a common communications interface.

Coordinate specific communications interface protocols with the equipment/system supplier/manufacturer (e.g. BACNet, etc.). Various equipment/systems shall include those listed in the drawings.

- E. Cutting and patching for installation of all equipment under this contract.
- F. Complete documentation, including submittals, data files, test reports, as-built documents, operating instructions, maintenance instructions and complete system warranty.
- G. All necessary labor to assist the balancer in initial and final air balancing.
 - 1. The BAS Contractor shall coordinate set-up and calibration of all airflow measuring and control instrumentation with the balancer.
- H. Furnish the following equipment to the HVAC/Plumbing Contractor for installation:
 - 1. Duct mounted air static pressure sensing elements/probes
 - 2. Airflow measuring stations
 - 3. All equipment (valves, dampers, actuators, drives, controllers, sensors, etc.) required to perform the sequences of operations.
 - 4. All others described in the specifications and drawings.
- I. All necessary labor to assist the Commissioning Agent in verifying proper operation of the control system in accordance with the specified sequences of operations.
 - 1. The BAS Contractor shall also include labor to assist the Commissioning Agent and Owner with point-to-point verification of all specified points to ensure complete and proper operation from the end device to the operator interface. This shall include input point monitoring, output point commands/overrides and setpoint adjustments.
 - 2. All necessary labor to assist the Commissioning Agent in pre-functional and functional testing.
 - a. The BAS Contractor shall complete pre-functional checkout sheets as requested by the engineer and commissioning agent.
 - b. The BAS Contractor shall complete and document the contractors/manufacturer's startup and commissioning process prior to the commissioning agent beginning functional testing.
 - 1) Evidence of successful completion of point to point checkouts, controller log-ic files and tuning parameters, as well as commissioning logs shall be turned over to the Commissioning Agent prior to the start of the functional testing process.
 - c. The BAS Contractor shall provide on-site assistance to the commissioning agent during the functional testing process to ensure that the testing can be completed in a timely manner.
 - 3. The BAS Contractor shall perform full point to point checkout on all inputs and outputs integrated into the BAS system and provide this documentation to the CxA and A/E prior to functional performance testing. Point to point checkout includes, but is not limited to, the following. Coordinate with the CxA and provide any additional execution or documentation requirements as directed.
 - a. Check each output (example shown for actuators)

- 1) Stroke correctly (when commanded full open the actuator and assembly are driven full open, when commanded full closed the actuator and assembly are driven full closed)
 - 2) Document that the actual field position matches BAS reading positions
 - b. Check each input (example shown for sensors)
 4. With an NIST (National Institute of Standards and Testing) calibrated measurement device appropriate to the sensor type and range being referenced, measure the actual field reading and compare it to the BAS sensor measured reading. Document on a log actual measured values, BAS readings, and correction factors. This shall be completed on all inputs inclusive of factory calibrated devices and sensors provided by other trades, disciplines, or vendors.
 5. Refer to all related commissioning specifications for additional commissioning requirements.
- J. The BAS Contractor shall monitor the system weekly for one year to verify performance of the system. This may be done by use of the modem and remote communications.

1.6 WORK INCLUDED UNDER OTHER SECTIONS OR DIVISIONS

- A. The following shall be included in the HVAC Contractor's scope of work:
1. Installation of all control and smoke dampers.
 - a. Provision to adjust ductwork and penetrations for installation of dampers smaller than ductwork.
 - b. Assembly of multiple section dampers with required interconnecting linkages, including shaft(s) extension through duct for external connection of damper actuators.
 2. Installation of airflow and static pressure sensing/measuring stations in ducts.
 3. Provision of access doors in ducts for service of control equipment.
- B. The following shall be included in the Electrical Contractor's scope of work:
1. Provision and installation of all fire alarm system related components and connections, including duct mounted smoke detectors.

1.7 SUBMITTALS

- A. Prior to system installation, submittal data shall be provided to the Architect and Engineer for approval. The contractor shall initiate a pre-submittal meeting with the engineer and commissioning agent to review the proposed system. The submittal contents shall include the following:
1. Damper schedule showing the following:
 - a. Damper tag and location.
 - b. Damper and duct sizes.
 - c. Pressure drop at design flow.
 - d. Quantity and model number of damper actuators.
 2. Shop Drawings which shall include:
 - a. Communications trunk cable schematic showing all DDC locations and all primary and secondary communications trunk data.

- b. Central system configuration complete with all peripheral devices, batteries, power supplies, diagrams, modems, etc., with interconnection diagrams.
 - c. Ladder type system schematic diagrams for each controlled system detailing all controllers, control devices and equipment, including all dampers, valves, actuators, field sensing devices, input/output transducers, panel details, etc. Include specific wire and terminal number information for all devices.
 - d. A written Sequencing of Operation shall be included for each system. These sequences shall appear on the shop drawings and shall describe in detail how each system will be controlled. Returning a retyped copy the sequences of operation from the contract documents shall not be acceptable.
 - e. A schedule of all connected points, including the point naming to be used, device type and range, output type and range, software address and DDC to which they are connected.
 - f. Equipment lists for each system drawing, of all proposed devices and equipment.
 - g. Field wiring diagrams showing all power supply connections; control wire connections to remote instruments and control devices; all wire connections to motor starters. Show all wire terminal designations including terminal designations used on motor control centers.
 - h. Interfaces with equipment provided by other contractors/manufacturers. Clearly illustrate and define these interfaces including:
 - 1) System, subsystem and specific component interfaces.
 - 2) Normal and abnormal conditions.
 - 3) Specific connections including terminal numbers.
 - 3. Data sheets and technical information for all devices. Information shall include range, units, line size ratings, power supply requirements, input and output signal descriptions, contact ratings and outline dimension drawings. Specific devices and device options shall be highlighted on data sheets showing multiple items.
 - 4. Sketches of system graphics showing all monitored systems, data (connected and calculated) point addresses and operator notations.
 - 5. Licensing agreement for each licensed software module (one copy to be executed by the
 - 6. Owner prior to software delivery).
 - 7. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE standard 135.
 - 8. Software Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
 - 9. ASC and CPC software programs. Include the following:
 - a. Software operating and upgrade manuals.
 - b. Software programs in electronic format.
- B. Submit for final record:
- 1. As-built shop drawings of all systems, control panels and components, incorporating all field modifications made, prior to the Owner's acceptance. Include control panel ladder diagrams, and terminations identified in the same manner as the wires are tagged in the field. Include all final room numbers, and equipment tags, etc.

2. Product data sheets and manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
3. Operation and Maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Maintenance manuals/instructions and lists of spare parts for each type of control device.
 - b. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - c. All system and device operation manuals/instructions for HVAC instrumentation and control system, including normal and emergency operation.
 - d. Complete set of operator workstation manuals include operation manuals for the graphical user interface.
 - e. Complete set of programming manuals for the central server, operator workstation, graphical user interface, BCs, CPCs, and ASCs.

1.8 QUALITY ASSURANCE

- A. Electric components shall be UL listed.
- B. Damper components shall comply with AMCA 500.
- C. Energy management components shall comply with NEMA EMC1.
- D. Enclosures shall comply with NEMA 250.
- E. Electrical requirements shall meet NFPA70.
- F. Installation as a part of the HVAC system shall comply with NFPA 90A.
- G. Control systems shall meet the requirements of ASHRAE Standard 90.1.
- H. Comply with ASHRAE 135 for DDC system components.
- I. The BAS specified herein shall be the product of one manufacturer except for certain components where specified and shall be designed, installed, programmed and commissioned by experienced personnel regularly employed by the manufacturer or the manufacturer's representative. If a local representative other than a manufacturer's branch office is utilized, the representative must be certified as an Authorized Controls Integrator (ACI) by the manufacturer.
- J. The systems control contractor shall have been in business a minimum of five years or have equivalent experience and have been the authorized installing contractor for the manufacturer of the system components for a minimum of two years.
- K. The control system shall be engineered, programmed and supported completely by the representative's local office that must be within 75 miles of project site.

- L. The supplier of the BAS shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished.
- M. The BAS supplier shall provide all tools, testing, and calibration equipment necessary to ensure reliability and accuracy of the system.
- N. Prototype, experimental, or "BETA-SITE" hardware or software shall not be used on this Project.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.10 COORDINATION

- A. Coordinate the work in this spec. section with all other trades. General provisions and mechanical systems are specified in other sections of Division 23.
- B. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- C. Coordinate all HVAC equipment connections with the unit manufacturer and supplier.
- D. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

1.11 WARRANTY

- A. In addition to warranty requirements of Division 01, The BAS shall be additionally warranted as follows:
 - 1. The BAS shall be warranted against defects (materials and labor) for a period of 1 year (or longer as required by Division 01) commencing on the date of Owner acceptance of the system (or as specified in Division 01).
 - 2. Owner acceptance of the system shall take place once the control system operation has been tested and accepted in accordance with the terms of this specification. Refer to the system demonstration, validation and acceptance section of this specification for more information.
 - 3. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate validation and acceptance phase and warranty start date and period.
 - 4. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within one business day of Owner's warranty

service request, except where to do so would potentially compromise the safety of the building occupants or cause damage to the facility or equipment. Where this is the case an immediate response shall be required.

5. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor- identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. No updates or upgrades shall be installed without the Owner's written authorization.
6. The BAS contractor shall modify the programs and/or setpoints as required during the first year of systems occupancy to determine the individual systems settings, to provide accurate and reliable space temperature control at the designated setpoints.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following manufacturers:
 1. Automated Logic-Installed by EMCOR
- B. The naming of any manufacturer does not constitute acceptance of their product nor waive responsibility to comply with all requirements of this specification.

2.2 SUBSTITUTION TECHNICAL PROPOSAL

- A. The entire BAS shall be furnished by a single supplier.
- B. The Contractor shall, prior to the time of entering his/her bid (10 working days minimum), submit a technical proposal for the Owner's and Engineer's evaluation, describing the manner of compliance with this minimum performance specification and detailing any exceptions or variations from this specification.
- C. Certify acceptance of all general provisions included in this specification, in writing.
- D. The technical proposal shall be provided in a binder, tabbed for easy reference. All drawings included shall be reduced in size and folded to fit in the proposal.
- E. Review of the submitted technical proposal shall not be construed as approval of the system and shall not relieve the system Contractor of fulfilling the requirements of the specifications in total.
- F. Review the mechanical installation and electrical installation requirements with the Division 23 and Division 26 Contractors respectively. Assume complete responsibility for assuring that all installation criteria relevant to the BAS is understood by those contractors and that their bid prices reflect the design parameters.

2.3 COMMUNICATIONS SYSTEM ARCHITECTURE

A. Enterprise Level Communications Network (ELCN)

1. The ELCN shall be based upon the ISO 8802-3 Ethernet standard (IEEE 802.3), utilizing Internet Protocol (IP) communications and operate at a minimum of 10/100 Mb/sec. The installation of all Ethernet wiring, accessories, and connectors shall conform to the ISO standard
2. The preferred connection media shall be 10 Base-T, Category 5e, Unshielded Twisted Pair (UTP-8) wire. The maximum single network run shall not exceed more than 250 feet. If additional distance is needed, the use of hubs or other Ethernet media will be acceptable. However, the 'cascading' of more than 3 hubs on a single segment will not be accepted.
3. The BAS shall utilize the ELCN for communications between the servers, routers, operator workstations and building controllers.
4. The BAS Contractor shall provide their own Ethernet communications network including all necessary Ethernet hubs, switches, routers, wiring/cabling etc. required to enable ELCN communications between the BAS equipment within the building. Provide an Ethernet switch as the point of connection to the Owner's IT network to allow for BAS web access from the Owners network.
5. With written permission from the Owner and the Owner's IT staff, the BAS system may utilize the Owner's IT infrastructure within the facility for the ELCN provided the bandwidth consumption is less than 5% of the total network bandwidth. Under no circumstances, shall the Owner's network be subject to failure and/or abuse.
 - a. The BAS Contractor shall be responsible for coordination with the Owner's IT staff to ensure that the BAS will perform in the Owner's environment without disruption to any other activities taking place on the infrastructure.
 - b. If permission is granted to use the Owner's IT network:
 - 1) The Owner shall provide the IP address(es) for the control system to utilize the Owners IT infrastructure.
 - 2) The BAS contractor is still responsible for the communications wiring between the BAS equipment and the Owner designated connection locations. Final connections shall be coordinated with the Owner's IT staff.
 - 3) The BAS Contractor shall conform to the Owner's IT standards for all wiring/cabling and connection details.
6. Acceptable protocols for this communications network are as follows
 - a. BACnet/IP protocol (Annex J) as defined by ANSI/ASHRAE Standard 135-2001.
 - 1) The system shall be a minimum conformance class 3, as identified by the standard. BACnet compatible systems that employ the use of proprietary 'gateways' will not be accepted unless otherwise noted.
7. All tools required to manage the ELCN shall be provided with the system

B. Building Level Communications Network (BLCN)

1. This communications network shall be limited to Building Controllers/Routers, Custom Programmable Controllers and Application Specific Controllers, and shall communicate bi-directionally with the ELCN.
2. The BAS shall utilize the BLCN for communications between the BCs and the CPCs/ASCs and communications between CPCs and ASCs.

3. Acceptable protocols for this communications network are as follows
 - a. BACnet via Master-Slave/Token-Passing protocol (MS/TP), as acknowledged by the ANSI/ASHRAE 135 standard. The MS/TP link shall operate at a 76.8 Kbps minimum, and utilize no more than 2 repeaters in any instance.
4. All tools required to manage the BLCN shall be provided with the system.

C. Remote Communications

1. The BAS installed in this building shall be integrated into the central BAS (main library) for remote monitoring.
2. Remote offsite communications to the Building Controllers shall be provided. In the event connection to the owner's Ethernet infrastructure is not made available from outside the district, dial-up communications shall be provided to allow remote operator stations to communicate with Building Controllers on an intermittent basis via telephone lines.
3. Operators at dial-up workstations shall be able to perform all operator functions as described for workstations connected via the network.
4. An operator shall be able to access buildings by selection of any facility by its logical name. The workstation dial-up program shall store the phone numbers of each remote site, so the user shall not be required to remember or manually dial telephone numbers.
5. Dial-up communications shall make use of industry standard 56K modems with auto ranging and voice grade telephone lines. Each standalone DDC panel may have its own modem, or a group of Standalone DDC panels may share a modem.
6. Cost of the phone line installation is the responsibility of the Owner.

2.4 SERVERS

A. Central servers shall provide the following minimum functions:

1. A central point of access to all data distributed throughout the system. When logged onto the server, the operator will be able to interact with any of the DDCs on the network, within their access privileges. User shall not be required to know the individual addresses of the building controllers in order to gain access to the data contained within those controllers.
2. Master clock services and time synchronization throughout the network.
3. Master global scheduling of all data throughout the network. The global schedules shall then be distributed to the appropriate local control panels throughout the network.
4. Master security functions including password definition and maintenance.
5. Central alarm management including routing of alarms to workstations, printers, pagers, or email.
6. Implementation of global control functions, such as demand limiting, on data located anywhere in the network.
7. An archive location for all data collected by the building controllers such as trends, alarm and event histories, and transaction logs.

B. Access to all information on the server shall be through the same user interface used to access the DDC panels.

- C. Servers shall communicate on the ELCN.
- D. Server functionality may be performed by a master BC, distributed amongst the BCs located throughout the ELCN, included as part of an operator workstation, or provided on a separate hardware platform. If a separate hardware platform is used, it shall meet or exceed the hardware specifications for an operator workstation.

2.5 OPERATOR WORKSTATIONS

- A. Operator workstations shall provide user access to the operator interface software.
- B. Operator workstations shall communicate on the ELCN.
- C. System shall be new. Refurbished systems are not acceptable.
- D. Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Acer
 - 2. Dell
 - 3. Gateway
 - 4. Hewlett Packard
- E. The hardware platform for servers and operator workstations shall meet or exceed the following specifications:
 - 1. Processor: Intel® Pentium® 4 with 2 GHz processor
 - 2. Installed Memory: 1 GB SDRAM, 400 MHz
 - 3. Hard Drive: 50 GB, 7200 rpm
 - 4. Optical Drive: Read/Write CD-ROM drive
 - 5. Monitor/Display: LCD flat panel display, 17" diagonal screen, 1280 x 1024 resolution, and 0.28 dot pitch
 - 6. Network Interface: Internal Ethernet 10/100
 - 7. Modem: 56Kbps
 - 8. Port Connectors: (6) USB 2.0, (1) Video, (1) Parallel, (2) PS/2, (1) Audio
 - 9. Input Devices: Keyboard, Wheel Mouse
 - 10. Include all parts required for BAS along with all cables
 - 11. Printer: Color (Inkjet or Laser) with all required cables
 - a. Print speed: 12 ppm (black)
- F. Installed software shall include:
 - 1. Current version of Microsoft® Windows operating system
 - 2. Current version of Microsoft® Office Standard Edition

2.6 PORTABLE OPERATOR'S TERMINAL

- A. A portable operator's terminal shall be furnished by the BAS contractor.
- B. The portable operator's terminal shall include all necessary software, tools and cables to directly connect to all BCs, CPCs and ASCs to accomplish the following:
 - 1. Upload, download and modification of all programs within the controller.

2. Monitor, command and override of all input, output and data points, including setup parameters, residing within the controller.
 3. Modification of all time schedules located within the controller.
- C. For controllers mounted in inaccessible locations, such as VAV box controllers mounted above the ceiling, access shall be obtained through a port at the local room thermostat.
- D. The portable operator's terminal shall also connect to the Owner's IT infrastructure and access the BAS through the ELCN in the same manner as a standard operator workstation.
- E. System shall be new. Refurbished systems are not acceptable
- F. Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Acer
 2. Dell
 3. Gateway
 4. Hewlett Packard
 5. Toshiba
- G. The hardware platform for a portable operators terminal shall meet or exceed the following specifications:
1. Processor: Intel® Pentium® 4 processor with 1.3 GHz processor
 2. Installed Memory: 512 MB SDRAM, expandable to 1 GB
 3. Hard Drive: 30 GB, 5400 rpm
 4. Optical Drive: 24x CD-ROM drive
 5. Display: 14" XGA active matrix, with 1024x768 pixel resolution, and 16.7M colors
 6. Network Interface: Internal Ethernet 10/100
 7. Port Connectors: (2) USB 2.0, (1) Video, (1) Audio
 8. Include all parts required for BAS along with all cables
- H. Installed software shall include:
1. Current version of Microsoft® Windows operating system
 2. Current version of Microsoft® Office Standard Edition

2.7 GRAPHICAL OPERATOR INTERFACE

- A. The graphical operator interface software may reside on a central server, an operator workstation or within a BC, and shall be accessed through an operator workstation or portable operators terminal.
- B. The operator interface shall be a graphical user interface and shall include the following basic utility features and application programs.
1. Display
 - a. The Operator Interface shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The operator interface shall

minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.

- b. At the option of the user, the Operator Interface shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all workstations.
 - c. The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance.
2. Security
 - a. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
 - b. Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually.
 - c. A minimum of five levels of access shall be supported
 - 1) Level 1 = Data access and Display
 - 2) Level 2 = Operator overrides
 - 3) Level 3 = Database Modification
 - 4) Level 4 = Database Generation
 - 5) Level 5 = Password Add/Modification
 - d. A minimum of 200 passwords shall be supported.
 - e. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, shall be limited to only those items defined for the access level of the password used to log-on.
 - f. User-definable, automatic log-off timers from 1 to 60 minutes shall be provided to prevent operators from remaining logged in inadvertently.
3. Operator Commands
 - a. The operator interface shall allow the operator to perform commands including, but not limited to, the following:
 - 1) Start-up or shutdown selected equipment
 - 2) Command and Override of all analog and digital outputs
 - 3) Adjust setpoints
 - 4) Add/Modify/Delete time programming
 - 5) Enable/Disable process execution
 - 6) Lock/Unlock alarm reporting for each point
 - 7) Enable/Disable Totalization for each point

- 8) Enable/Disable Trending for each point
 - 9) Override PID Loop setpoints
 - 10) Enter temporary override schedules
 - 11) Define Holiday schedules
 - 12) Change time/date
 - 13) Enter/Modify analog alarm limits
 - 14) Enter/Modify analog warning limits
 - 15) View limits
 - 16) Enable/Disable Demand Limiting for each meter
 - 17) Enable/Disable Duty Cycle for each load
 - 18) Download operating systems, databases and application programs to stand- alone DDC panels and ASCs
4. Scheduling
 - a. Operator's workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.
 - b. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.
 - c. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.
 5. Reporting
 - a. Reports shall be generated automatically or manually, and directed to computer displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - 1) A general listing of all points in the network
 - 2) List all points currently in alarm
 - 3) List of all off-line points
 - 4) List all points currently in override status
 - 5) List of all disabled points
 - 6) List of all points currently locked out
 - 7) List of all weekly schedules
 - 8) List of Holiday Programming
 6. Alarm Handling
 - a. Operator's workstation shall provide audible, visual, and printed means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) currently running. Printout of alarms shall be sent to the assigned terminal and port.
 - b. System shall provide a log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment and identification of operator acknowledging alarm.
 - c. Alarm messages shall be in user-definable text (English or other specified language) and shall be entered either at the operator's terminal or via remote communication.
 7. Demand Limiting

- a. System shall include a demand limiting program. Load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
 - b. Shedding shall include minimum of 4 priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one the loads shall be shed/restored in a "first off-first on" mode and in the other the loads are just shed/restored in a linear fashion.
 - c. Each load shall have adjustable shed time durations and shall have the ability to have an associated comfort override input that allows the load to be restored based on an uncomfortable condition.
8. Paging
 - a. Provide the means of automatic alphanumeric paging of personnel for user- defined FMS events.
 - b. System shall support both numeric and alpha-numeric pagers, using Alphanumeric, PET, or IXO Protocol at the Owner's option.
 - c. Users shall have the ability to modify the phone number or message to be displayed on the pager through the system software.
 - d. System shall utilize pager schedules to send pages to the personnel that are "on- call".
 - e. Contractor shall be responsible for providing a modem for connection to the paging service.
- C. Dynamic Color Graphic Displays:
 1. Color graphic floor plan displays, and system schematics for each piece of mechanical equipment shall be provided to optimize system performance analysis and speed alarm recognition.
 2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.
 3. Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention. Display value updates shall occur once a minute at a minimum.
 4. Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
 5. The BAS contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers etc.), complete mechanical systems, (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
 6. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
 - a. Define symbols
 - b. Position and size symbols
 - c. Define background screens
 - d. Define connecting lines and curves

- e. Locate, orient and size descriptive text.
 - f. Define and display colors for all elements
 - g. Establish correlation between symbols or text and associated system points or other displays.
 - 7. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points, which aid the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels.
- D. Site Specific Customizing Software
- 1. Software shall allow the user to modify and tailor the BAS to the specific and unique requirements of the equipment installed, the programs implemented and to staffing and operational practices. Online modification of system configuration, program parameters and database shall be provided via menu selection and keyboard entry of data into preformatted self-prompting templates. As a minimum, the following modification capability shall be provided:
 - 2. Operator assignment capability shall include designation of operator passwords, privilege(s), starting graphic and auto sign off.
 - 3. Peripheral assignment capability shall include assignment of segregation groups to consoles and printers, designation of backup consoles and printer.
 - 4. System configuration/diagnostic capability shall include communications and peripheral port assignments, DDC assignments to the communications network, DDC enable/disable, assignment of command trace to points, and initiation of diagnostics.
 - 5. System text add/change capability shall include English descriptors for graphic points, action messages for alarms, runtime and trouble condition messages.
 - 6. Time/Schedule change capability shall include time/date set, time/occupancy schedules, holiday schedules, daylight savings time schedules and activity defined schedules. All time and calendar scheduling and schedule modification shall be accomplished in a hardware independent manner.
 - 7. Points shall be definable as to coloration, animation, audible rate and duration, point descriptors (60 characters minimum), operator messages (480 characters minimum), printer options, alarm archival option, alarm and warning limits and engineering units.
 - 8. Point related change capability shall include system/point enable/disable; runtime enable/disable; assignment of point to point classes/groups, analog value offset, lockout, runtime, setting a fixed input or output value, alarm values or conditions.
 - 9. Application program change capability shall include enable/disable of BAS programs, BAS program parameter changes, assignment of comfort limits, global points, time and event initiators, time and event schedules and enable/disable time and event programs.

2.8 WEB INTERFACE

- A. The BAS shall include a web-based interface that allows for a minimum of 5 simultaneous users. An operator shall be able to access all the information in the system via this interface. The web-page software shall not require a per user licensing fee or annual fee.

- B. The web-based interface shall be accessible via industry standard PCs/Laptops, utilizing “off the shelf” technology, residing on the Intranet/Internet. These PCs shall not require the purchase of any additional software from the BAS manufacturer for use as a BAS workstation. Interface to the BAS from these PCs shall be accomplished via standard Web browsers.
- C. Web browsers shall be a standard current version of Internet Explorer™ or Netscape Navigator™. No special vendor-supplied software shall be needed on the client computers. All information shall be viewable, real-time and updated automatically without user interaction.
- D. In its entirety, the “Thin” client web application shall not be dependent upon the use of third party plug-ins (i.e. Shockwave, Flash Player, etc.).
- E. Web page graphics shown on the browser shall be replicas of the BAS displays. Operators shall need no additional training to understand the information presented on the web pages when compared to what is shown on the BAS displays.
- F. Values displayed on the web page shall update automatically without requiring a manual refresh of the page.
- G. An operator, via the web, shall have the ability to:
 - 1. Navigate real-time through the system
 - 2. Change setpoints.
 - 3. Manually command or override any input, output or value.
 - 4. View and acknowledge active alarms
 - 5. Create and edit building schedules
 - 6. Trend any point or value and display graphically or in table format
 - 7. Display a summary of overridden points
 - 8. Create new users or user groups, assign access privileges and edit existing user access privileges
- H. Access via the web browser shall utilize the same hierarchical security scheme as the BAS system. User shall be asked to log in once the browser makes connection to the web page. Once the user logs in, any and all changes that are made shall be tracked by the BAS system. The user shall be able to change only those items that the user has authority to change.
- I. The Owner shall provide the IP address(es) for remote access, to the control system, via the Internet.

2.9 STAND ALONE BUILDING CONTROLLERS (BC)

- A. Stand-alone BC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. The BC shall provide an interface between the enterprise level operator interfaces and databases, and the building level controllers.
- B. Each panel shall have sufficient memory to support its own operating system and database. Non-volatile memory shall be incorporated for all critical controller

configuration data and 72- hour battery back-up shall be provided for all volatile memory.

- C. All BCs shall communicate on the ELCN as well as the BLCN.
- D. Each BC shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASC) and Custom Programmable Controllers (CPC).
- E. The BC shall have the following minimum capabilities:
 - 1. Global control processes
 - 2. Energy Management Applications
 - 3. Scheduling
 - 4. Alarm Management
 - 5. Historical/Trend Data for all points
 - 6. Time and Calendar synchronization
 - 7. Maintenance Support Applications including network management functions for LonWorks® based devices
 - 8. Operator I/O
 - 9. Dial-Up Communication
 - 10. Manual Override Monitoring
 - 11. Integration of all LonWorks® or BACnet controller data
- F. The BC shall provide at least one RS-232C serial data communications ports for simultaneous operations of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations and panel mounted or portable Operator Terminals. The BC shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or network terminals.
- G. The BC shall monitor the status or position of all hardware overrides and include this information in logs and summaries to inform the operator that automatic control has been inhibited. BCs shall also collect override activity information for daily and monthly reports.
- H. The BC shall provide local status indication for each binary input and output for constant, up- to-date verification of all point conditions without the need for an operator I/O device.
- I. Each BC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The BC shall provide both local and remote annunciation of any detected component failures or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each BC and shall not require the connection of an operator I/O device.
- J. Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to run in the same conduit as high voltage wiring where acceptable by electrical code.
- K. In the event of the loss of normal power, there shall be an orderly shutdown of all BCs to prevent the loss of database or operating systems software. Upon restoration of

normal power, the BC shall automatically resume full operation without manual intervention. Should BC memory be lost for any reason, the user shall have the capability of reloading the BC via the ELCN or via the local RS-232C port.

- L. Each BC shall automatically and continuously maintain a history of all associated temperatures to allow users to quickly analyze comfort and equipment performance over the past 24 hours. A minimum of two samples per hour shall be stored.
- M. Each BC shall have the ability to collect data for any property of any point connected on its BLCN.
- N. The BC shall have the ability to backup its database of points, control processes, logs, trends, histories etc. to the central server.
- O. BCs used in conditioned ambient space shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non-condensing. BCs used outdoors shall be rated for operation at -40°F to 140°F and 5 to 95% RH, non-condensing.

2.10 CUSTOM PROGRAMMABLE CONTROLLERS (CPC), APPLICATION SPECIFIC CONTROLLERS (ASC), AND UNITARY THERMOSTAT CONTROLLERS (UTC)

- A. General
 - 1. All stand-alone controllers shall communicate on the BLCN.
 - 2. Each controller shall be a microprocessor-based, multi-tasking, real-time digital control processor. Each controller shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network.
 - 3. Each controller shall have sufficient memory to support its own operating system and databases including appropriate energy management applications. Each controller shall retain its program, control algorithms, and setpoint information in non-volatile memory such that a power failure of any duration does not necessitate reprogramming of the controller, and it shall return to normal operation upon restoration of power.
 - 4. The controller's setpoints and input/output point data shall be accessible through any operator workstation, portable operator's terminal, or any BC connected to the BAS system.
 - 5. Each stand-alone controller for major central station systems, i.e., air handling units, heat exchangers, pumping systems, etc., shall have a local display with operator keypad to view/adjust setpoints and start/stop equipment. Provide a means to prevent unauthorized personnel from accessing setpoint adjustments and equipment control functions.
 - 6. The controller shall provide the ability to download and upload configuration data, both locally at the controller and via the BAS communications networks.
 - 7. Provide HOA switches for each digital output and label accordingly.
 - 8. One copy of any programming tool required to configure or program the controllers shall be provided to the Owner along with all appropriate documentation.

9. Controllers used in conditioned ambient space shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non-condensing. Controllers used outdoors shall be rated for operation at -40°F to 140°F and 5 to 95% RH, non-condensing

B. BACnet Controllers

1. Controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Controllers shall be minimum BACnet conformance class 3.
2. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information
3. All controllers shall have BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.

C. Custom Programmable Controllers

1. Stand-alone CPCs shall be provided for, but not limited to, the following types of applications as shown on the drawings: Custom Air Handling Units, Boiler Plant and Chiller Plant.

D. Application Specific Controllers

1. Stand-alone ASCs shall support, but not be limited to, the following types of systems to address specific applications as shown on the drawings: Rooftop Air Handlers, VAV/CAV terminal units, and Fan Coil Unit.
2. Application Specific Descriptions:
 - a. Fan Coil Unit Controllers:
 - 1) Fan Coil Unit Controllers shall support, but not be limited to, the operational sequences as described in the drawings.
 - 2) At a minimum, Fan Coil Unit Controllers shall support the following types of point inputs and outputs:
 - a) Modulated heating and cooling control outputs
 - b) Space temperature inputs
 - c) Analog space temperature setpoint adjustment inputs
 - d) Binary unoccupied override inputs
 - 3) The modes of operation supported by the Fan Coil Unit Controllers shall minimally include, but not be limited to, the following:
 - a) Daily / weekly schedules
 - b) Occupancy mode
 - c) Unoccupied mode
 - d) Temporary override mode

E. Unitary Thermostat Controllers (UTC)

1. Stand-alone UTCs shall support, but not be limited to, the following types of systems to address specific applications as shown on the drawings: Computer Room Air Conditioning (CRAC) Units, and Cabinet Heaters.
2. The UTC shall support, but not be limited to, the control sequences for these applications as described in the drawings.

3. When applied to a CRAC unit, the UTC shall be powered via the CRAC unit to allow it to operate on emergency power.
4. The UTC shall be a wall mounted controller that can be operated in stand-alone mode and under supervisory mode via the BC.
5. The UTC shall have a local LCD display, and pushbuttons or thumbwheels for local adjustments.
6. At a minimum, the UTCs shall support the following types of point inputs and outputs:
 - a. Fan control outputs
 - b. Staged heating and cooling outputs
 - c. Economizer control outputs
 - d. Space temperature inputs
 - e. Analog space temperature setpoint adjustment inputs
 - f. Binary unoccupied override inputs
7. The modes of operation supported by the UTC shall minimally include, but not be limited to, the following:
 - a. Daily / weekly schedules
 - b. Occupancy mode
 - c. Unoccupied mode

2.11 ELECTRONIC CONTROLS

A. Temperature sensors

1. Space Temperature Sensors
 - a. Space temperature sensors shall utilize RTD or thermistor type elements terminated on clamp type connectors or plug-in strip with manufacturer's standard locking cover and shall meet or exceed the following specifications:
 - 1) Accuracy: $\pm 1\%$ of sensor range
 - 2) Sensing Range: 55° F to 85° F
 - b. Space temperature sensors shall include the following features:
 - 1) Public Spaces
 - a) Blank Face Sensor with no buttons
 - b) Occupied Override (VAV and CAV terminal units): Integral push button
 - c) No LCD Display
 - 2) Private Office Spaces
 - a) Setpoint Adjustment: $\pm 3^\circ$ F adjustment range
 - b) Occupied Override (VRF terminal units): Integral push button
 - c) LCD Display
2. Rigid Stem Sensors
 - a. Small duct (less than 14 ft²) and pipe mounted sensor shall utilize rigid stem temperature sensors and shall be RTD or thermistor type, with ceramic or epoxy encapsulated wire wound nickel element and shall meet or exceed the following specifications:
 - 1) Accuracy: $\pm 0.1\%$ of sensor range
 - 2) Sensing Range: -50° F to 220° F
 - 3) Sheath: Stainless steel or copper
 - 4) Insertion Length (Duct): 8" (4" for terminal unit discharge air temperature)

- 5) Insertion Length (Pipe): 2-1/2" in stainless steel or brass thermowell.
 - b. Sensors used in liquid measuring applications shall be furnished with compatible thermowells.
 - c. Sensors used in duct measuring applications shall be furnished with duct element holder.
 3. Averaging Temperature Sensors
 - a. Large duct (14 ft² and greater or where shown) and temperature sensors used inside air handling units or rooftop units shall be averaging type sensors, be continuous nickel or platinum element encased in an aluminum capillary, and shall meet or exceed the following specifications:
 - 1) Accuracy: $\pm 0.5\%$ of sensor range
 - 2) Sensing Range: -50° F to 220° F
 - 3) Length: 8 feet minimum
 - b. Capillary shall be firmly supported by a system of mechanical clips and be protected from damage due to mechanical vibration.
 4. Outside Air Sensors
 - a. Outside air sensors shall be RTD or thermistor type, have watertight inlet fittings, be shielded from direct sunlight, and shall meet or exceed the following specifications:
 - 1) Accuracy: $\pm 0.1\%$ of sensor range
 - 2) Sensing Range: -50° F to 220° F
- B. Temperature Transmitters
1. Temperature transmitters shall utilize RTD or thermistor elements and shall output a 4- 20 mA linear signal over the specified range.
 2. Housings for transmitters mounted on supply ducts or in non-hazardous spaces shall be NEMA 1. Housings for transmitters in outdoor air, on out-door air plenums or intake ducts, or in spaces whose ambient temperature is below 55°F, shall be gasketed die- cast aluminum, NEMA 3R minimum.
 3. Transmitters in outdoor air shall be provided with approved sun shields.
 4. Transmitters shall meet or exceed the following specifications:
 - a. Zero Point and Span Adjustment: Adjustable over a minimum of 75% of range
 - b. Range:
 - 1) Space: -50° F to 120° F
 - 2) Duct: -50° F to 300° F
 - 3) Outside Air: -50° F to 150° F
 - 4) Chilled Water: -50° F to 200° F
 - 5) Hot Water: -50° F to 300° F
- C. Humidity Transmitters
1. Humidity transmitters shall utilize thin film polymer capacitor sensing, shall output a linear 4-20 mA or DC voltage signal over the instrument range. Output shall be temperature compensated, and shall meet or exceed the following specifications:
 - a. Accuracy: $\pm 2\%$ R.H. over entire range
 - b. Hysteresis: 1% R.H. maximum
 - c. Stability: $\pm 1\%$ R.H. maximum per year
 - d. Range: 0% to 100% R.H. (non-condensing)

2. Humidity transmitters shall be enclosed in NEMA 1 housing minimum. Transmitters in outdoor air or on outdoor air intake plenums or ducts shall be enclosed in NEMA 3R housing. In addition, transmitters in outdoor air shall be housed within a baffled aluminum or stainless steel rain shield.
- D. Differential Pressure Transmitters – Air Systems.
1. Differential pressure transmitters shall measure pressure signals from space or duct probes and shall output a linear 4-20 mA or DC voltage signal.
 2. Transmitter range shall be selected for the application. Transmitter full span shall not exceed twice the maximum system operating pressure in W.C.
 3. Differential pressure transmitters shall meet the following performance standards as a minimum:
 - a. Accuracy: $\pm 1\%$ of F.S. (includes hysteresis, linearity, and repeatability)
 - b. Over-Range Protection: 28" W.C.
 - c. Calibration: Zero point and span adjustable to within 0.1% of full span
 4. Transmitter shall include a second order, low pass active electronic filter to eliminate input signal noise from the output signal.
 5. Duct static pressure probes shall be single probe type, with rounded tip, mounting flange and extended connection. Construction shall be extruded aluminum or stainless steel. Sensor and transmitter shall be enclosed in NEMA 1 housing minimum.
- E. Static Pressure Sensing – Air Ducts
1. Elements
 - a. Static pressure sensing elements for air ducts having horizontal or vertical dimension of 36 inches or greater shall be the traverse probe type. Probe shall be constructed of extruded aluminum or stainless steel and shall contain multiple static pressure sensing points connected to an averaging manifold to produce a non-pulsating signal with an accuracy of $\pm 1\%$. Shall be enclosed in NEMA 1 housing minimum.
 - 1) Accuracy: Overall $\pm 1\%$ of span
 - b. Static pressure sensing elements for air ducts having horizontal or vertical dimension of less than 36 inches shall be single probe type, with rounded tip, mounting flange and extended connection. Construction shall be extruded aluminum or stainless steel. Shall be enclosed in NEMA 1 housing minimum.
 - 1) Accuracy: Overall $\pm 1\%$ of span
 2. Transducers
 - a. Transducers shall measure pressure signals from the duct probes and shall output a linear 4-20 mA or DC voltage signal.
 - b. Transducer range shall be selected for the application.
 - c. Transducers shall meet the following performance standards as a minimum:
 - 1) Accuracy: $\pm 1\%$ of F.S.
 - d. Static pressure transducers shall be located in the control panel. Sensing tubes shall be run from the sensing element to the transducer.
- F. Carbon Dioxide Sensors
1. Carbon dioxide sensors (CO₂) shall measure conditions from space or duct and shall output a linear 4-20 mA or DC voltage signal. Sensors shall

utilize non-dispersive inferred technology (NDIR) and meet or exceed the following specifications:

- a. Accuracy: ± 50 ppm
- b. Range: 0 to 2000 ppm
- c. Response Time: 2 minutes
- d. Drift: Less than 30 ppm/year
- e. Calibration Interval: 5 years
- f. LCD Display

G. Flow Meters/Transducers:

1. The flow transducers shall utilize a nonmagnetic sensing mechanism with a forward- swept rotating impeller to produce a frequency signal proportional to flow. The flow transducers shall have an achievable accuracy of ± 1 percent of flow rate with flow velocities of 1 to 30 fps.
2. The flow meter shall be constructed of brass with a glass reinforced impeller, tungsten carbide shaft and glass reinforced polyphenylene sulfide housing. The unit shall be both insertable and removable through a gate type valve when the pipe is under pressure.
3. Provide minimum of 10 straight pipe diameters upstream and 5 diameters downstream for each field installed flow transducer.
4. Provide an insertion/extraction tool as needed to allow removal and replacement of flow transducer while the system is under pressure.
5. Flow Transducer shall be equivalent to Onicon F-1210 with 4-20 mA signal.

2.12 ELECTRIC CONTROLS

A. Differential Pressure switches 0" to 10" W.C. – Air

1. Switch shall be diaphragm actuated SPDT, minimum rating 5 amps resistive 120 VAC, enclosed in NEMA 1 housing. Maximum deadband shall be 0.30 inches W.C. Setpoint shall be fully adjustable over switch range.
2. Diaphragm material shall be silicone rubber or Buna-N. Actuator assembly enclosure shall be entirely of aluminum or steel. Switches mounted outdoors, within panels located outdoors, or within ducts or plenums shall be provided with NEMA 4 enclosures. Pressure connections shall be NPT.
3. Differential pressure switches shall be Barksdale, Mercoid or Dwyer.

B. Current Operated Switches - Equipment Status

1. Switch shall be self powered, solid state with an adjustable current sensing range of 1 to 175 amps.
2. Device shall be suitable for 175% of rated motor equipment current.

C. Limit Switches:

1. Limit switches shall have a minimum rating of 10 amps resistive at 120 VAC. Switch assemblies shall be two pole single or double throw, and enclosure shall meet NEMA 3R requirements as a minimum. Switch actuation rod shall be aluminum or stainless steel.

D. Electric Space Thermostats

1. Provide wall mounted or unit mounted electric space thermostats as indicated on the Drawings.

2. Electric space thermostats shall be heavy duty type, with contact rating exceeding the switched load. Setpoint adjustment shall be concealed.
 3. Provide heavy duty lockable transparent guards for all thermostats switching line voltage (120 VAC) and all thermostats located in public areas.
- E. Control Relays
1. Control relay contacts shall be rated for no less than 140% of the switched load, or a minimum continuous rating of 10 amps at 120 VAC. Relay coils shall be rated for continuous duty at 100% + 10% of the normal coil pilot voltage.
 2. Relays mounted within panels may be plastic encapsulated socket mounted type or modular design with multiple convertible contacts, as required.
 3. Relays located outside of panels shall be housed in enclosures rated for the intended location.
 4. All relays shall contain an indicator light to show the energized/de-energized status of the relay coil.

2.13 ELECTRONIC ACTUATORS FOR DAMPERS

- A. Actuators shall include electronics to receive the digital controller's signal. Torque of the actuator shall be the working pressure of the system for valves, the total static differential of an air system, plus 25% safety factor.
- B. Actuators shall have a spring return to the fail safe position.

2.14 DAMPERS

- A. Dampers required for the systems shall be furnished under this automatic control subcontract, except where specifically required to be furnished with the air handling units. Dampers shall be turned over to the Sheet Metal Subcontractor, together with complete instructions for installation. Where modulating operation is required of the dampers, they shall be opposed blade type. Parallel blade dampers are acceptable only on mixing applications. Mixing sections may have parallel blade dampers on the return air and opposed blade dampers on the outside air.
- B. Dampers shall be constructed with not larger than 6" blades and not less than 16-gauge construction, mounted on a 2" channel frame, complete with bronze or nylon bearings and heavy duty connecting control links. All dampers shall be rugged construction and very tight fitting with rubber edges on both edges of each blade and compression type jamb seals on the frame.
- C. Dampers shall be low-leakage type, as required to meet the requirements of ASHRAE Standard 90.1.
- D. Maximum panel size is 48" wide x 48" high. Damper blades shall be galvanized steel or aluminum. Provide a damper operator for each panel. No jack-shafting is permitted. The Sheet Metal Subcontractor will install access doors to inspect and service the dampers.

2.15 CONTROL PANELS

- A. BAS control panels/enclosures shall be provided and installed where shown on the associated HVAC Drawings and where needed for complete installation of BAS components. Coordinate mounting locations and utility requirements with other trades.
- B. All controllers, transformers, power supplies and relays shall be mounted in enclosures. These items may also be mounted within the HVAC equipment's control section if permitted by the HVAC equipment manufacturer, and if adequate space is provided.
- C. Enclosures shall be designed for control and instrumentation applications, able to be mounted directly on the wall, and capable of adequately protecting the enclosed product in the environment in which it is mounted.
- D. Enclosures shall not be mounted directly on HVAC equipment such as air handling unit housings. Field constructed Unistrut racks may be used where necessary, provided rack is constructed adequately to support the enclosure.
- E. Enclosures shall be NEMA 1 or as required by the location and local code requirements when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 or as required by the location and local code requirements when installed in other than a clean environment. Outdoor enclosures and/or enclosures in wet ambient conditions shall be weatherproof.
- F. Enclosures shall have hinged, locking doors.

2.16 AIRFLOW MEASURING SYSTEMS

- A. Airflow Measuring Systems shall consist of an airflow element (duct or fan inlet) and an electronic transducer.
 - 1. Airflow measurement elements location and sizing shall be confirmed in the field by local factory representative. Velocity calculation and corresponding differential pressure calculations will be calculated accordingly.
 - 2. Elements shall be installed in strict accordance with the manufacturer's published requirements; therefore, it shall be the responsibility of the contractor to verify and installation, to assure that accurate primary signals are obtained.
- B. Airflow Element:
 - 1. Airflow elements shall be designed and built to comply with accepted practice for traversing as defined in the ASHRAE Handbook of Fundamentals. The number of sensing points on each element, and the quantity of elements utilized at each installation, shall comply with ASHRAE Standard #111 for equal area traversing.
 - a. Signal amplifying sensors requiring flow correction (K factors), or employing reduced sensing points less than ASHRAE Standard #111 are not acceptable.
 - b. Direct pressure readings are required. Indirect sensing methods such as thermal mass flow wires, subject to humidity limitations and insulating

effects produced by commonly present particulate matter shall not be acceptable.

2. Differential pressure sensing elements shall be constructed of anodized aluminum or stainless steel and shall contain multiple static pressure sensing points connected to an averaging manifold to produce a non-pulsating signal.
- C. Electronic Transducers:
1. Each transducer shall be selected for its respective duty. Outside Air, Supply, Exhaust and/or Return airflow.
 2. Transducers shall output a linear 4-20mA or 0-10VDC signal of the corresponding CFM airflow value. The transducer shall be factory set for a full scale value equal to 110% of the maximum design capacity of the flow measuring element served for variable air volume applications, or 200% of the design operating value for constant volume applications.
 3. Each transducer shall have integral square root function, scaling function, and filter.
- D. Fan inlet airflow measuring systems shall meet or exceed the following specifications:
1. Full Scale Accuracy: $\pm 0.25\%$
 2. Velocity Range: 0 to 10,000 fpm
 3. At the Contractor's option, airflow measuring devices utilizing the principle of vortex shedding for air velocity measurement may be used for fan inlet airflow measurement, and shall meet or exceed the following specifications:
 - a. Full Scale Accuracy: $\pm 0.5\%$
 - b. System Accuracy: $\pm 2\%$ of flow rate
- E. Duct airflow measuring systems shall meet or exceed the following specifications:
1. Full Scale Accuracy: $\pm 0.25\%$
 2. Velocity Range: 0 to 5,000 fpm
- F. Outside airflow systems shall meet or exceed the following specifications:
1. System Accuracy: $\pm 3\%$ of flow rate
 2. Full Scale Accuracy: $\pm 0.5\%$
 3. Velocity Range: 180 to 1,4000 fpm
 4. Outside airflow measuring systems shall additionally include a local LCD readout of airflow value in CFM, shall auto zero, and shall have temperature compensation to correct for air density.
- G. Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Air Monitor Corp.
 2. Paragon Controls, Inc.
 3. Tek-Air
 4. Ultratech

2.17 LICENSE AGREEMENT SOFTWARE

- A. The BAS Contractor agrees to provide to the Owner and Owner agrees to accept the software products provided under these specifications. A software licensing agreement shall be executed between the BAS Contractor and the Owner's authorized

signatory before the software is distributed. This licensing agreement shall grant to the Owner a non-exclusive license to use the software product solely for Owners' own use on the designated installation.

- B. All project developed software shall be turned over to and become property of the Owner. This shall include all ASC and CPC programs, graphic images, and project databases.

2.18 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27.

2.19 CONTROL TUBING

- A. Control tubing shall be furnished and installed complete, connected up and operating to serve all pressure sensing devices (e.g. static pressure sensors, etc.) and all pneumatic control devices required to accomplish the specified functions
- B. Tubing shall conform to the following:
 - 1. Hard Copper - Tubing shall be hard copper with wrought copper or bronze fittings with solder joints. Hard copper may be used without restrictions.
 - 2. Soft Copper - Tube shall be annealed soft copper with flared or compression joints. Soft copper shall not be used in exposed locations except at final connection to devices.
 - 3. Polyethylene, Open - Tubing shall be fire retardant, self-extinguishing, virgin polyethylene, single or multiple tube. Tubing shall meet requirements of ASTM Tests D638 and D1693

2.20 IDENTIFICATION LABELS

- A. Component Identification
 - 1. Label all sensing devices, controllers, transducers and actuation devices. Identify and label each item as they appear on the control shop drawing diagrams.
 - 2. Labels shall be preprinted or computer-printed type. "P-Touch" or other consumer style labels are acceptable.
 - 3. Labeling scheme must be approved by the owner, any labeling not approved by the owner and engineer shall be relabeled at the contractor's expense.
- B. Cable and Wire Identification
 - 1. Label all wires and connectors at each end with marker tape. Identify and label each item as they appear on the control shop drawing diagrams.
 - 2. Provide temporary cable labels for use during cable pulling and installation; provide permanent type printed labels on cable after cables are terminated.
 - 3. Label each cable between 2 and 6 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

4. Marker tape shall be vinyl or vinyl-cloth, self-adhesive wraparound type, with cable/wire identification machine printed by thermal transfer or equivalent process.
5. Labeling scheme must be approved by the owner, any labeling not approved by the owner and engineer shall be relabeled at the contractor's expense.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all conduit, wiring and cable, and install all equipment in first-class manner, using proper tools, equipment, hangers, and supports, and in locations as required for a neat, attractive installation. No material shall be exposed if it is possible to conceal it. Exposed material shall be installed only with consent of the Engineer.
- B. Install the system as recommended by the Manufacturer, using only equipment recommended or acceptable to the Manufacturer.
- C. Support all sensors as recommended by the Manufacturer where inside equipment, such as ductwork. Sensors in the space shall be in small, attractive housings designed for that purpose and mounted on an electrical junction box.
- D. Control tubing shall be supported at frequent intervals to prevent sagging (4 ft. centers maximum for soft copper). Tubing run in exposed areas shall be run in an inconspicuous manner following natural building lines. In finished portions of the building, tubing shall be run concealed.
- E. Extreme care shall be used in making connections to other equipment, such as boilers and chillers, to see that the safeties on this equipment are not inadvertently by-passed or overridden by the BAS.
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels to identify all control components.
- H. All equipment having moving parts and controlled by the BAS shall be provided with warning labels no less than 2" (50mm) in height, and in bright warning colors, stating that the equipment is remotely started by automatic controls. Such labels shall be posted clearly in the area of any moving parts, such as belts, fans, pumps, etc.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 except wiring smaller than No. 12, where ½" size conduit may be used.
- B. Install building wire and cable according to Division 26 except as explicitly noted below.
- C. Install communication, signal, and fiber-optic cables according to Division 27.

- D. Comply with all codes for electrical work. Run all power wiring in conduit. All sensor and control wiring located in mechanical rooms and other exposed areas shall be run in conduit. All wiring run inside the walls shall be in conduit. All equipment located outside shall be in suitable weather tight enclosures.
 - 1. Low voltage wiring concealed above accessible ceilings does not require conduit except as required in air plenums.
 - 2. Open wiring in air plenums shall be UL Listed for such use and so labeled, otherwise it shall be run in conduit.
 - 3. Open wiring shall be bundled and supported at 3 ft. intervals with a system of J-hooks and plastic tie wraps secured to permanent building structure.
- E. Circuits serving control panels and transformers for low voltage service shall be independent and used for no other purpose. These shall originate from the nearest appropriate electrical panel. Circuit wiring from the electrical panel shall be included in this contract. These circuits shall be clearly identified at the panels. Coordinate with the Electrical Contractor.

3.3 SOFTWARE

- A. Load and debug the software to provide a complete operation BAS system, and operate the system to prove function of each system. Where necessary, the sensor shall be heated or cooled to demonstrate the correct function. Provide careful evaluation of the operation of chillers and boilers at part and full load under control of the BAS.
- B. The BAS Contractor shall review the programs with the Engineer in the programming stage to make sure that the programmer understands the Engineer's intent and that the program will carry out that intent.
- C. Provide the Owner with a bound copy of the complete information on the equipment and all components, including programming, as well as instruction books on reprogramming of the system for future modifications of the system, if desirable.

3.4 SYSTEM DEMONSTATION, VALIDATION AND ACCEPTANCE

- A. The Contractor shall satisfactorily demonstrate the complete operating sequence, including daily mode changes, seasonal mode changes and any associated energy management routines for all equipment being controlled including, but not limited to:
 - 1. Air handling units
 - 2. Exhaust air systems
 - 3. VRF Systems
 - 4. Miscellaneous equipment, including but not limited to the following:
 - a. Ventilation systems
 - b. Cabinet heaters
 - c. Unit heaters
 - d. Lighting control integration
- B. The Contractor shall satisfactorily demonstrate the proper operation of all associated system points as defined in drawings, including but not limited to the following:

1. All analog input sensing device readings, including temperature, humidity, pressure, flow, volume, CO2 sensors, etc.
 2. All analog output controls including valves, dampers, speeds, etc., including proper ranging.
 3. All binary input status reading.
 4. All binary output or two position controls including start/stops, open/closed, on/off, etc.
 5. All pulsed inputs including flow meters, electric meters, etc., including proper ranging.
- C. Upon the completion of all work, tests and specific function demonstrations, and at a time agreed upon, the Architect and the Contractor shall, in conjunction with other contractors, operate the systems installed by him/her, in all parts, at his/her own expense for sufficient length of time to demonstrate the mode of operation and definitely determine whether the systems as a whole are in first-class working condition. Any defects that may develop during this demonstration period shall be immediately corrected by the Contractor at his/her own expense, and the systems placed in first-class working condition. Contractor shall return to site in season to demonstrate (and instruct operating personnel) an additional 24 hours so that both heating and cooling season operation is demonstrated.
- D. Final Check-Test-Start of System Summary
1. Check and/or oil all electric motors furnished under control system.
 2. Lubricate all damper bearings.
 3. Check damper travel, adjust and tighten all set screws.
 4. Lubricate valve stems, check packing.
 5. Calibrate all instruments.
 6. Check and verify all circuitry.
 7. Calibrate and check all controllers, fusing, and electrical connections.
 8. Run software through program diagnostics and debug as required.
 9. Startup and test operation of variable frequency drive with factory authorized personnel.

3.5 TRAINING

- A. All training shall be by the BAS manufacturer and shall utilize specified manuals, as-built documentation and on-line help utility. All training sessions shall be video recorded and shall become property of the Owner upon completion of training. Media format for video recording shall be coordinated with the Owner. Refer to Division 01 Section "Demonstration and Training."
- B. Operator training shall include a minimum of forty (40) hours encompassing, but not limited to the following topics:
1. Sequence of Operation review.
 2. Sign on-Sign off.
 3. Selection of all displays and reports.
 4. Commanding of points, keyboard and mouse mode.
 5. Modifying English text.
 6. Use of all dialogue boxes and menus.
 7. Modifying warning limits, alarm limits and start-stop times.

8. System initialization.
 9. Download and initialization of all stand-alone DDC panels and ASCs.
 10. Purge and/or dump of historical data.
 11. Use of Portable Operators Terminal.
 12. Troubleshooting of sensors (determining bad sensors).
 13. System maintenance procedures.
- C. Supervisor training shall include an additional minimum of eight (8) hours encompassing, but not limited to the following topics:
1. Password assignment/modification.
 2. Operator assignment/modification.
 3. Operator authority assignment/modification.
 4. Point disable/enable.
 5. Terminal and data segregation/modification.
 6. Use of portable operator terminal.
 7. Use of spreadsheet package with system data.
- D. Programmer training shall include a minimum of two (2) additional four (4) hour sessions encompassing, but not limited to the following topics:
1. Software review of Sequence of Operation flowcharts.
 2. Use of CPC/ASC programming tool including use of any associated plug-ins.
 3. Modification of control programs, including all server, BC, CPC, and ASC programs.
 4. Add/Delete/Modify data points.
 5. Use of diagnostics.
 6. System maintenance procedures.
 7. Review of initialization.
 8. Upload/download and off-line archiving of all system software.
 9. Creating and modifying color graphics.
- E. Operator training shall be performed on site and specific dates/times shall be coordinated with the Owner. Programmer training shall be for Owner-designated personnel and shall be scheduled by the Owner with two week notice anytime during the warranty period.
- F. Printed training material shall be provided by the contractor to all training event attendees.

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SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet metal ducts and fittings.
2. Sheet metal materials.
3. Duct liner.
4. Rectangular duct connection systems.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Requirements

1. ANSI/SMACNA 006-2006 (SMACNA 006) HVAC Duct Construction Standards – Metal and Flexible Third Edition. All ductwork shall be in conformance with this standard.
2. Structural Performance: Duct hangers, supports, and seismic restraints (where applicable) shall withstand the effects of gravity, wind, and seismic loads and stresses within limits and under conditions described in SMACNA 006, ASCE/SEI 7, and local requirements.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.2 SYSTEM DESCRIPTION

- ###### **A.**
- Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the Architect/Engineer. Accompany requests for layout modifications with calculations showing the proposed layout will provide original design results without increasing system total pressure.

1.3 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of the following products:
 - a. Prefabricated ductwork and fittings.
 - b. Liners and adhesives.

- c. Rectangular duct connection systems.
- d. Sealants and gaskets.
- e. Seismic-restraint devices.

2. Shop Drawings:

- a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
- b. Fittings, including details of construction.
- c. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
- d. Elevations of top and bottom of ducts along with applicable elevations of structural elements.
- e. Dimensions of main duct runs from building grid lines.
- f. Reinforcement and spacing.
- g. Duct material and gauge thickness by pressure class.
- h. Seam and joint construction.
- i. Penetration details through fire-rated, smoke barriers and other rated partitions.
- j. Equipment installation based on equipment being utilized on this project.
- k. Duct accessories, including dampers, turning vanes, and duct access doors.
- l. Length of application of acoustic duct liner where it will be applied.
- m. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- n. Other systems installed in the same space as ducts where order of installation affects access.
- o. Ceiling and wall mounted access doors and panels required to provide access to dampers, controls and other operating devices.
- p. Ceiling mounted items, including light fixtures, diffusers, grilles, speakers, smoke detectors, sprinklers, other electrical devices, equipment and building structural members.
- q. On each drawing, include a tabular list of each fan system's ductwork represented on that drawing and the total square foot surface area of each fan's duct system illustrated on the drawing.
- r. Shop drawings shall be submitted prior to the fabrication or installation of the ductwork and serve as the foundation for coordination between various trades to maintain required ceiling heights.

3. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

- a. Test procedures used.
- b. Test results that comply with requirements.
- c. Failed test results and corrective action taken to achieve requirements.

B. Leakage Testing Documentation: Contractor shall submit a written report to the authority having jurisdiction in which ducts designed at static pressures more than 3" wg pressure class have been leak tested and that the air leakage class is less than 6.0 per the Energy Code. Provide duplicate submittal to the Owner and the Engineer.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for steel hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum hangers and supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance: Applicable requirements in:
 - 1. NFPA 90A.
 - 2. NFPA 90B.
 - 3. NFPA 96.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1.
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Damage: Handle, transport, and store ducts to avoid damage. Damaged ductwork is not acceptable.
- B. Protection: Protect ducts from mechanical damage, weather, and exposure to chemicals (including road salt). Do not permit insulation materials to get wet under any circumstances. Remove insulation that is or has been wet from the project site, and replace the insulation with undamaged new materials.
- C. Ductwork and associated components shall be stored on blocking in a clean dry area to prevent damage and to prevent the entrance of dirt, debris, foreign matter and moisture.
- D. Ductwork shall be adequately supported during storage to prevent sagging or bending.
- E. Provide temporary storage, delivery and handling in accordance with SMACNA Duct Cleanliness for New Construction Guidelines, Intermediate Level.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA 006 based on indicated static-pressure class. The figure numbers below reference that standard.
 - 1. Transverse Joint: Figure 2-1.
 - 2. Longitudinal Seam: Figure 2-2.

3. Pressure Class Gage and Reinforcement: Table 2-1 through Table 2-52 and Figure 2-3 through Figure 2-18.
4. Elbow: Figure 4-2 (Use the following types only unless specifically approved by the Engineer.):
 - a. Type RE 1 (radius elbow).
 - b. Type RE 2 (square throat elbow with turning vanes).
 - c. Type RE 3 (radius elbow with vanes).
 - d. Type RE 5 (dual radius elbow).
 - e. Type RE 6 (mitered elbow without turning vanes) only for angles not greater than 45 degrees.
5. Turning Vanes: Figures 4-3 and 4-4. Figure 4-9 short radius vanes in accordance with Chart 4-1 are acceptable.
6. Branch Connection:
 - a. Diverging Flow: Figure 4-5 (all types). Figure 4-6 (following types only):
 - 1) 45-degree entry to rectangular branch.
 - 2) 45-degree lead-in to round branch.
 - 3) Conical connection.
 - 4) Bellmouth connection.
 - 5) Conical or bellmouth spin-in fitting only for pressure class 2" WG or less.
 - b. Converging Flow: Figure 4-5 (all types) and Figure 4-6 (all types). Conical or bellmouth spin-in fitting is acceptable only for pressure class 2" WG or less.
7. Offset, Transition, or Obstruction: Figure 4-7 (all types) and Figure 4-8 (Figure B and C). Do not use Figure 4-8 Figure A (pipe through duct), Figure D (mitered offsets around obstruction, or Figure E (split duct around obstruction) unless specifically approved by the Engineer.

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. McGill Airflow LLC.
 2. Sheet Metal Connectors, Inc.
- B. Duct Size: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA 006 based on indicated static-pressure class.
- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A; and NAIMA AH124.

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.
 3. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 4. Coat insulation with antimicrobial coating.
 5. Cover inner surfaces of insulation with polyester film complying with UL 181, Class 1.
- E. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A.
1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.
 3. Maximum Temperature: 180 deg F.
- F. Inner Duct: Minimum 24-gauge (0.028-inch) galvanized steel, stainless steel, or aluminum as indicated. Inner duct having 3/32-inch-diameter perforations, with overall open area of 23 percent. Solid, unperforated inner duct in fittings unless otherwise indicated. Solid, unperforated inner straight duct only if so indicated.
- G. General Fabrication Requirements: Conform to the equivalent single-wall duct requirements in the "Single-Wall Rectangular Ducts and Fittings" Article above based on the static pressure class and the size of the outer duct.

2.3 SINGLE-WALL ROUND OR FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA 006 Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Eastern Sheet Metal.
 - b. FlaktGroup SEMCO.
 - c. Lindab Inc.
 - d. McGill AirFlow LLC.
 - e. Sheet Metal Connectors, Inc.
 2. Transverse Joint: Figure 3-1 (all types).
 3. Longitudinal Seam: Figure 3-2 (all types). Do not use type RL-5 (grooved seam pipe lock or flat lock), RL-6 (snaplock), RL-7 (snaplock), or RL-8 (snaplock) seam for duct over 1" WG pressure class. Fabricate round duct larger than 90-inch diameter with butt-welded longitudinal seam.

4. Pressure Class Gage and Reinforcement: Table 3-2 through Table 3-15 and Figure 3-3.
5. Elbow: Figure 3-4. Use centerline radius of 1.5 diameters for each elbow unless space constraints prevent a radius that large; in that event, the radius may be reduced to that indicated in Table 3-1 with mitered segments. If space constraints prevent a radius as large as indicated in Table 3-1, a mitered elbow with turning vanes similar to Figure 4-3 and Figure 4-4 may be used. Do not use an adjustable elbow for duct over 1" WG pressure class.
6. Branch Connection with Diverging or Converging Flow: Figure 3-5 and Figure 3-6. All types are acceptable for pressure class 2" WG or less duct. For pressure class 3" WG or more duct, use 90-degree tee fitting with oval-to-round tap, 45-degree lateral fitting, conical fitting, or wye fitting. Reducers may be incorporated into the fitting. Use only factory-fabricated fittings, not saddles or field-fabricated taps, for pressure class 3" WG or more duct.
7. Offset, Transition, or Obstruction: Figure 4-7 and Figure 4-8 modified for round or flat oval duct. Do not use Figure 4-8 Figure A (pipe through duct), Figure D (mitered offsets around obstruction), or Figure E (split duct around obstruction) unless specifically approved by the Engineer.
8. Flat Oval: Figure 3-7 and applicable figures for equivalent round duct.

2.4 DOUBLE-WALL ROUND OR FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. Eastern Sheet Metal.
 2. FlaktGroup SEMCO.
 3. Lindab Inc.
 4. McGill Airflow LLC.
 5. Sheet Metal Connectors, Inc.
- B. Outer Duct: Comply with SMACNA 006 Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class.
- C. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A; and with NAIMA AH124.
 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.
 3. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 4. Coat insulation with antimicrobial coating.
 5. Cover inner insulation surfaces with polyester film complying with UL 181, Class 1.

- D. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.
 - 3. Maximum Temperature: 180 deg F.
- E. Inner Duct: Minimum 24-gauge (0.028-inch) galvanized steel, stainless steel, or aluminum as indicated. Inner duct having 3/32-inch-diameter perforations, with overall open area of 23 percent. Solid, unperforated inner duct in fittings unless otherwise indicated. Solid, unperforated inner straight duct only if so indicated.
- F. General Fabrication Requirements: Conform to the equivalent single-wall duct requirements in the "Single-Wall Round or Flat-Oval Ducts and Fittings" Article above based on the static pressure class and the size of the outer duct.

2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA 006 for 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 unless otherwise indicated.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 or G90.
 - 2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils on sheet metal surface of ducts and fittings exposed to corrosive conditions and minimum 1 mil on opposite surface.
 - 3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts, listed and labeled for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated.
- F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surfaces of the duct. Apply an untreated clear coating to the exterior surfaces.
2. Antimicrobial compound tested for efficacy by a nationally recognized testing laboratory and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound with a minimum hardness of 2H when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723.
5. Shop-Applied Coating Color: Black or white, as indicated.
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

H. Reinforcement Shapes and Plates:

1. Steel Duct: ASTM A 36/A 36M, steel plates, shapes, and bars; black or galvanized.
2. Aluminum Duct: ASTM B209 alloy 6061-T6 members or steel members isolated from the aluminum with butyl rubber, neoprene, or EPDM gasket materials.
3. Other Duct Materials: Reinforcement materials compatible with the duct materials at contact points.

I. Tie Rods: Materials compatible with duct materials. Galvanized steel or stainless steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.6 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, and NAIMA AH124.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Owens Corning.
 - b. CertainTeed Corporation: Insulation Group.
 - c. Johns Manville.
 - d. Knauf Insulation.
2. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
3. 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 and registered by the EPA for use in HVAC systems.

4. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.
 5. Water-Based Liner Adhesive: Comply with NFPA 90A 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.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC.
 2. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 3. Surface-Burning Characteristics: Flame-spread index no greater than 25 and smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.
 4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A. For indoor applications, adhesive with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- 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- or 0.135-inch diameter shank, length to suit depth of insulation indicated with integral galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel, aluminum, or stainless steel (as appropriate); with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA 006 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 install liner in rectangular ducts with longitudinal liner joints at locations other than corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Lined duct following unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are 2500 fpm or more.
 - d. Other locations as indicated.
9. Terminate liner with buildouts (metal hat sections) at dampers, turning vane assemblies, or other devices. Secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 RECTANGULAR DUCT CONNECTION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 1. Ductmate Industries, Inc.
 2. Hart & Cooley, Inc. Ward Industries.
 3. McGill Airflow LLC.
- B. Connection System: Rectangular duct transverse joint connection, reinforcement, and sealing system with roll-formed metal flanges, metal corner pieces, sealants, gaskets, and cleats.

2.8 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a flame-spread index no greater than 25 and a smoke-developed index no greater than 50 when tested according to UL 723; certified by a nationally recognized testing laboratory.

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. Sealant: Modified styrene acrylic.
3. Water resistant.
4. Mold and mildew resistant.
5. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
6. Service: Indoor and outdoor.
7. Service Temperature: Minus 40 to plus 200 deg F.
8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
9. For indoor applications, sealant with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). For school projects, sealant complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). For school projects, sealant complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.9 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts or other materials compatible with duct materials.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods; galvanized rods with threads painted with zinc-chromate primer after installation; or stainless steel all-thread rods and nuts.
- C. Strap and Rod Sizes: Comply with SMACNA 006 Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Cables:
 1. Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
 2. Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
 3. End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Structural shapes and plates of materials compatible with duct materials and environmental conditions. Support material shall match duct construction material.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION GENERAL REQUIREMENTS

- 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 losses for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings or Coordination Drawings.
- B. Install ducts according to SMACNA 006 unless otherwise indicated.
- C. Unless otherwise indicated, install ducts vertically plumb or horizontally level, and parallel and perpendicular to building lines. Avoid diagonal runs to maximum extent possible.

- D. Install ducts with a minimum clearance of 2 inch plus allowances for insulation thickness and access requirements.
- E. Cable hangers may only be used on low pressure (2" wg construction and lower) round spiral ductwork which is not insulated and has a diameter 10" or less. Utilize the double lock method such that the lower loop is clinched tight to the ductwork and the cable is vertical. Utilize manufacturer's top attachment device.
- F. Provide duct offsets needed to avoid interferences with structure, finishes, piping, other ducts, conduit, etc. Coordinate the work with all trades to minimize such offsets. Install ducts with fewest joints possible.
- G. Do not penetrate ducts with conduit or piping.
- H. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- I. Secure couplings with sheet metal screws. Install screws at maximum intervals of 12", with a minimum of 3 screws in each round metallic duct coupling.
- J. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections. Do not field-cut taps for branch connections in ducts with SMACNA pressure class magnitude more than 2 in wg.
- K. Install round or flat-oval ducts in maximum practical lengths to minimize joints.
- L. Do not install any duct in an electrical equipment room unless that duct serves that room.
- M. Do not install any duct in an elevator equipment room unless that duct serves that room.
- N. Do not install any duct over an electrical transformer, electrical switchgear, or an electrical panel unless approved in writing by the Engineer.
- O. Maintain clearances required in the National Electric Code for electrically-powered items.
- P. Where ducts pass through interior partitions or 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 type and thickness as the duct. Overlap openings on all sides by at least 1-1/2 inches.
- Q. Where ducts pass through fire-rated partitions, install fire dampers unless otherwise indicated. Comply with requirements in other Division 23 Sections for fire dampers.
- R. Where ducts pass through smoke partitions, install smoke dampers unless otherwise indicated. Comply with requirements in other Division 23 Sections for smoke dampers.
- S. Install ductwork takeoffs at smoke dampers such that there is a minimum of 24" between the damper and the start of the first takeoff.

- T. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts that are to be exposed in finished spaces from damage including dents, surface scratches, and markings. Exposed ducts must be undamaged and present a clean, neat appearance in materials and workmanship.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system in finished spaces.
- C. Grind welds to provide smooth surfaces 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 and inlets.
- E. Repair or replace ducts that do not comply with these requirements.

3.3 DUCT SEALING

- A. In accordance with ASHRAE 90.1, seal all ducts to SMACNA 006 seal class A with all transverse joints, longitudinal seams, and duct wall penetrations sealed. Seal openings for rotating shafts (including dampers) with bushings or other devices. However, do not seal an opening if sealing the opening would void a manufacturer's listing. Spiral lock seams in round or flat oval ducts do not require sealing unless leakage is detected.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA 006 Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
- C. Hanger Spacing: Comply with SMACNA 006 Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports. Other types of hangers may be used if so indicated or if approved by Engineer.

- E. Vertical Ducts: Support vertical ducts with steel angles or channel secured to the sides of the ducts with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 16 feet.
- F. Upper Attachments: Install upper attachments secured to structural members. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials. Do not attach duct supports to roof decks.

3.5 CONNECTIONS

- A. Make connections to motorized equipment with flexible connectors complying with other Division 23 Sections. Comply with SMACNA 006 for branch, outlet, inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a primer compatible with the duct material.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test ductwork sections that have a design static pressure class magnitude of 4-inch wg or more regardless of duct locations. Test representative duct sections totaling no less than 50 percent of total installed duct area. Obtain Engineer's approval of specific sections to be tested beforehand.
 - 3. Test all ductwork located outdoors.
 - 4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 5. Test for leaks before applying external insulation.
 - 6. 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.
 - 7. Give at least seven days notice for testing.
 - 8. Tests must demonstrate that tested ducts meet SMACNA leakage class 4 or less. If any tested section of ductwork fails to meet this requirement, perform the following at no additional cost to the Owner:
 - a. Leak test 100 percent of the ductwork in every duct system with any failed section.

- b. Provide additional sealing of ductwork to eliminate excessive leakage in failed sections. If necessary, replace duct sections.
- c. Retest 100 percent of the ductwork in every duct system with any failed section.
- d. Continue sealing and retesting until the entire system is proven to meet the leakage requirement. Note that once a section is proven to meet the leakage requirement that section does not need to be tested again unless it is damaged later.

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 Engineer, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems." The cleanliness level is acceptable if the net weight of debris collected on the filter media does not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DUCT CONSTRUCTION REQUIREMENTS

A. Fabricate ducts with materials, pressure classes, and insulations indicated on Drawings.

END OF SECTION 23 31 13

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Flange connectors.
 - 3. Turning vanes.
 - 4. Duct-mounted access doors.
 - 5. Flexible connectors.
 - 6. Duct accessory hardware.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.
 - a. For fire-dampers, smoke-dampers, combination fire- and smoke-dampers, and ceiling dampers include installation instructions.
 - b. For smoke-dampers and combination fire- and smoke-dampers include power, signal, and control wiring diagrams.
 - c. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Closeout Submittals:
 - 1. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- C. Maintenance Material Submittals:
 - 1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 2. Fusible Links: Furnish quantity equal to at least 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA 006 for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or Type 316 as indicated. Unless indicated otherwise, No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ruskin Company.
 - 2. American Warming and Ventilating.
 - 3. McGill Airflow LLC.
 - 4. Nailor Industries Inc.
 - 5. Pottorff.
 - 6. Safe Air – Dowco Products.
 - 7. Vent Products Co., Inc.
- B. Round Manual Volume Damper: Diameter 20 inches or less, air velocity 1500 fpm or less, and duct static pressure class 2-inch or less. Galvanized steel sleeve with

reinforcing beads. Single galvanized steel blade on axle with molded synthetic bearing at each end of axle and locking quadrant on standoff bracket. Basis of design Ruskin MDRS25.

- C. Round or Oval Manual Volume Damper: Diameter 48 inches or less, air velocity 4000 fpm or less, and duct static pressure class 10-inch or less. Galvanized steel construction for galvanized steel duct. Type 304 stainless steel construction for type 304 stainless steel or aluminum duct. Type 316 stainless steel construction for type 316 stainless steel duct. Rolled hat channel frame arranged for slip-in mounting. Single blade (or dual blades with center mullion for oval duct over 36 inches wide). Neoprene blade edge seals. Class II leakage rating. Blade mounted on axle with stainless steel sleeve bearing at each end of axle and locking quadrant on standoff bracket. Basis of design Ruskin CDR25 or CDO25.
- D. Rectangular Manual Volume Damper: Height 12 inches or less, air velocity 1500 fpm or less, and duct static pressure class 1-inch or less. Galvanized steel sleeve with blade stop. Single galvanized steel blade on axle with molded synthetic bearings and locking quadrant on standoff bracket. Basis of design Ruskin MD25.
- E. Rectangular Manual Volume Dampers: Height 5 inches or more, air velocity 1500 fpm or less, and duct static pressure class 3-inch or less. Galvanized steel hat channel frame with mitered and welded corners and blade stop. Flanged for attaching to wall and flangeless for installing in duct. Multiple single-thickness formed galvanized steel blades with opposed blade linkage enclosed in frame. Blades mounted on axles with molded synthetic bearings. Control shaft extended beyond frame with locking quadrant on standoff bracket. Basis of design Ruskin MD35.

2.4 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Ductmate Industries, Inc.
 - 2. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.5 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA 006.
- D. Vane Construction: Single wall for vanes up to 48 inches wide and double wall for larger dimensions.

2.6 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA 006. Double wall, rectangular door. Galvanized sheet steel with insulation fill and thickness as indicated for duct pressure class. Butt or piano hinges and cam locks, quantities as indicated in SMACNA 006. Doors airtight and suitable for duct pressure class. Galvanized sheet steel frame with bend-over tabs and foam gaskets. Vision panel where indicated.
- B. Pressure Relief Access Door: Door and frame of galvanized sheet steel. Double wall door with insulation fill and metal thickness applicable for duct pressure class. Open outward for positive-pressure duct and inward for negative-pressure duct. Factory set at 3.0-inch to 8.0-inch wg positive or negative. Door retaining device. Neoprene or foam rubber seal.

2.7 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene. Minimum weight 26 oz./sq. yd. Minimum tensile strength 480 lbf/inch in the warp and 360 lbf/inch in the filling. Service temperature range minus 40 to plus 200 deg F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone. Minimum weight 24 oz./sq. yd. Tensile strength 530 lbf/inch in the warp and 440 lbf/inch in the filling. Service temperature range minus 50 to plus 250 deg F.

2.8 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories in accordance with manufacturers' instructions.
- B. Install duct accessories according to applicable details in SMACNA 006 for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- D. Compliance with ASHRAE/IESNA 90.1 restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft or control damper (as indicated) at inlet of exhaust fan or in exhaust duct close to exhaust fan unless otherwise indicated.
- E. Install volume dampers only in ducts constructed to magnitude 2" pressure class or less. Provide at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- F. Flag all manual volume dampers in ducts concealed above a ceiling with high-visibility tape.
- G. Set each damper fully open position before testing, adjusting, and balancing.
- H. Install test holes at fan inlets and outlets and elsewhere as indicated.
- I. Install access door with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Two-Hand Access: 12 by 12 inches.
 - 2. Head and Hand Access: 18 by 12 inches.
 - 3. Head and Shoulders Access: 24 by 18 inches.
 - 4. Body Access: 30 by 18 inches.
 - 5. Body plus Ladder Access: 30 by 30 inches.

- 6. Where duct width does not permit door size specified above, one dimension of door size may be reduced to 2 inches less than duct width.
- K. Install flexible connectors to connect ducts to equipment. If vibrating equipment is internally isolated from casing, provide rigid duct connections.
- L. For fan developing static pressure of 5-inch wg or more, cover flexible connector with loaded vinyl sheet held in place with metal straps.
- M. Install duct test hole where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate each damper to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed and that door can open fully.
 - 3. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

SECTION 23 33 46

FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulated flexible ducts.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of product.
 - 2. Shop Drawings: For flexible ducts. Include plans showing locations and mounting and attachment details.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA 006 "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.
- C. Comply with Air Diffusion Council "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill Airflow LLC.

3. Thermaflex; a Flex-Tek Group.
 4. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
 4. Insulation R-Value: R6.
- C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
 4. Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
- B. Non-Clamp Connectors: Liquid adhesive plus tape.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts according to applicable details in SMACNA006 for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions or correct misalignments.
- D. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with liquid adhesive plus tape or draw bands.
- F. Installation:
1. Install ducts fully extended.
 2. Do not bend ducts across sharp corners.

3. Centerline radius of bends of flexible ducting shall not be less than one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns except as noted elsewhere.

G. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends approximately one duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches on center.

END OF SECTION 23 33 46

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SECTION 23 34 16

CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: For each product.
 - 1. Backward-inclined centrifugal fans.

1.2 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevation.
- B. Operating Limits: Classify according to AMCA 99.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data:
 - a. Include rated capacities, furnished specialties, and accessories for each fan.
 - b. Certified fan performance curves with system operating conditions indicated.
 - c. Certified fan sound-power ratings.
 - d. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - e. Material thickness and finishes, including color charts.
 - f. Dampers, including housings, linkages, and operators.
- B. Informational Submittals:
 - 1. Field quality-control reports.
- C. Closeout Submittals:
 - 1. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.
- D. Maintenance Material Submittals:
 - 1. Belts: One spare set for each belt-driven unit.

1.4 QUALITY ASSURANCE

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

B. 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.

PART 2 - PRODUCTS

2.1 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.
4. Twin City Fan & Blower.

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven or direct-driven (as indicated) centrifugal fan consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fan as factory-assembled unit, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff. Panel joints welded for airtight assembly.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing (if necessary to install fan).
4. Spun inlet cone with flange.
5. Outlet flange.

D. Backward-Inclined Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades fastened to shaft with set screws.

2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

G. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Inlet Screens: Grid screen of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Spark-Resistant Construction: AMCA 99.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fan.

8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in another Division 23 Section.

2.3 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301. Factory test fans according to AMCA 300. Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans and accessories in accordance with manufacturer's instructions.
- B. Install centrifugal fans level and plumb.
- C. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- D. Lift and support units with manufacturer's designated lifting or supporting points.
- E. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, indirect to drain with pipe sizes matching the drain connection.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
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 belt-driven 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 where applicable.
 6. Provide and verify proper lubrication for bearings and other moving parts.
 7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 8. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 9. Shut unit down and reconnect automatic temperature-control operators.
 10. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 23 34 16

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SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.2 SUBMITTALS

- A. Action Submittal:
 - 1. Product Data: For each product indicated, include the following:
 - a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - b. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
 - 2. Color Samples for Initial Selection: For each product with factory-applied color finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Titus.
 - 2. Price.
 - 3. Krueger.
 - 4. Hart & Cooley.
 - 5. Metalaire.
 - 6. Nailor Industries Inc.
 - 7. Tuttle & Bailey.

2.2 DIFFUSERS, REGISTERS, AND GRILLES

- A. Architectural Ceiling Diffuser:

1. Material: Steel.
 2. Finish: Baked enamel, white.
 3. Face Size: 24 by 24 inches.
 4. Face Style: Plaque.
 5. Mounting: Lay-In or Surface Mount, refer to schedule.
 6. Accessories: Factory-insulated R-6 foil-backed insulation.
- B. Sidewall Supply Grille:
1. Material: Steel.
 2. Finish: Baked enamel, white.
 3. Mounting: Surface or Duct Mount.
 4. Face Arrangement: Double Deflection.
 5. Blades: Adjustable, front blades parallel to long dimension.
 6. Blade Spacing: 3/4-inch.
 7. Accessories: Opposed Blade Damper.
- C. Continuous Slot Diffuser with Pattern Controller:
1. Material: Aluminum.
 2. Finish: Baked enamel, white border.
 3. Mounting: Ceiling or Sidewall, refer to schedule.
 4. Pattern Controller: Adjustable or Fixed, refer to schedule.
 5. Slot Width: Refer to schedule.
 6. Number of Slots: Refer to schedule
 7. Length: Refer to schedule.
- D. Exposed Spiral Duct Supply Grille:
1. Material: Aluminum.
 2. Finish: Baked enamel, white.
 3. Mounting: Duct.
 4. Face Size: Refer to schedule
 5. Face Arrangement: Double Deflection.
 6. Blades: Adjustable, parallel to long dimension.
 7. Blade Spacing: 3/4-inch.
 8. Accessories: Air Scoop Damper.
- E. Eggcrate Grille and Register:
1. Material: Aluminum.
 2. Finish: Baked enamel, white.
 3. Face Arrangement: 1/2-by-1/2-by-1/2-inch.
 4. Face Size: Refer to schedule.
 5. Frame: 1-1/4 inches wide.
 6. Mounting: Lay-In or Surface Mount, refer to schedule.
 7. Damper (Register Only): Adjustable opposed-blade assembly.
- F. Sidewall Return Grille:
1. Material: Steel
 2. Finish: Baked enamel, white.
 3. Mounting: Surface or Duct Mount.
 4. Face Arrangement: 35° Fixed.
 5. Blades: Fixed, blades parallel to long dimension.
 6. Blade Spacing: 3/4-inch.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Provide sponge rubber gasket, mounting frame, and concealed fastener mounting on all surface mounted grilles and registers.
- E. Paint inside portion on all ductwork and plenums visible behind air device non-specular flat black enamel.
- F. Provide additional support for grilles, registers, and diffusers mounted in lay-in ceiling.
- G. Provide non-specular flat black steel blank-offs behind all unused portions of linear air devices.
- H. Coordinate exact location of diffusers, grilles and registers with area smoke detectors, lights, and electrical devices. Air devices shall not be closer than 3 feet from area smoke detector.
- I. Final location of diffusers, registers and grilles shall be from architectural reflected ceiling plans.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 74 33

DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes factory-packaged units capable of supplying outdoor air conditioned for room distribution.

1.2 SUBMITTALS

- A. Action Submittals:

- 1. Product Data: For each type of product:

- a. Unit dimensions and weight. Include shipping splits and weight by segment. Include shipping and installed weights.
- b. Cabinet material, metal thickness, finishes, insulation, and accessories.
- c. Fans:
 - 1) Certified fan-performance curves with system operating conditions indicated. Include flow, pressure drop, speed, brake HP, drive losses, and fan efficiency.
 - 2) Certified fan-sound power ratings.
 - 3) Fan construction and accessories (including belt guards, plenum fan cages, and piezometer rings).
 - 4) Motor ratings, electrical characteristics, and motor accessories. Include efficiencies and statement of VFD compatibility.
 - 5) Vibration isolation and restraint, including thrust restraints.
- d. Certified coil-performance ratings with system operating conditions indicated, tube thickness, fin thickness, and materials.
- e. Dampers, including housings, linkages, operators, and linkage ratings.
- f. Filters with performance characteristics including initial and final pressure drops at rated airflow. Include information on differential pressure gages and filter clips.
- g. Sound ratings for overall unit performance: Radiated sound, discharge air sound and entering air sound.
- h. Pressure drop across each segment of the air handling unit.
- i. Wiring diagrams: Power, signal and control wiring. Differentiate between factory-installed components and wiring and field-installed components and wiring.
- j. Electrical component information, including lights, receptacle, conduit and junction boxes.

- k. Access door construction, including door thickness, door operator type and material, handle locations and hinge information, thermal pane window information and test port locations.
- l. Drain pan construction with invert of drain pan dimensioned from the bottom of unit. Identify drain piping with trap heights detailed.
- m. Airflow measuring probe calibration data.
- n. Test reports on leakage and vibration.
- o. All furnished specialties and accessories.
- p. Installation and startup instructions include fan bearing lubrication schedule and requirements.

B. Informational Submittals:

- 1. Startup service reports.
- 2. Sample Warranty: For special warranty.

C. Closeout Submittals:

- 1. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

D. Maintenance Material Submittals:

- 1. Furnish additional materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Filters: One set for each unit.
 - b. Gaskets: One set for each access door.
 - c. Final Fan Belts and Fan Sheaves: One set for each air-handling unit belt-driven fan sized by the test and balance contractor as required to deliver the necessary airflow through the system accounting for all system losses.
 - d. Paint: One quart-size can of touch-up paint for the exterior finish of each air handling unit provided.

1.3 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. Comply with AHRI 410 for components, construction and rating. Certify coils to AHRI 410.
- C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- D. ASHRAE Compliance: Comply with applicable sections of the following:
 - 1. ASHRAE 52.1.
 - 2. ASHRAE 62.1.

3. ASHRAE 90.1.

1.4 SOURCE QUALITY CONTROL

- A. AHRI 430 Certification: Air-handling units and their components shall be factory tested according to AHRI 430 and shall be listed and labeled by AHRI.
- B. AHRI 1060 Certification: Air-handling units that include air-to-air energy recovery devices shall be factory tested according to AHRI 1060 and shall be listed and labeled by AHRI.
- C. AMCA 301 or AHRI 260: Air-handling unit fan sound ratings shall comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data," or AHRI 260, "Sound Rating of Ducted Air Moving and Conditioning Equipment."
- D. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- E. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- F. Refrigerant Coils: Factory tested to minimum 450-psig internal pressure and to minimum 300-psig internal pressure while underwater, according to AHRI 410 and ASHRAE 33.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect, pack, and secure loose-shipped items within the air-handling units. Include detailed packing list of loose-shipped items, including illustrations and instructions.
- B. Protect, pack and secure control devices, motor control devices, and other electronic equipment. Do not store electronic equipment in wet or damp areas even when they are sealed and secured.
- C. Enclose and protect control panels, electronic devices, and variable frequency drives. Do not store equipment in wet or damp areas even when they are sealed and secured.
- D. Seal openings to protect against damage during shipping, handling, and storage.
- E. Wrap indoor units with a tight sealing membrane. Wrapping membrane shall cover entire AHU during shipping and storage. Cover equipment, regardless of size or shape. Alternatively, AHU must be tarped for shipment and storage.
- F. Wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust, and corrosion. Keep equipment clean and dry.

- G. Tarp outdoor units to protect against rain and road debris during shipping.
- H. Clearly mark AHU sections with unit tag number, segment sequence number, and direction of airflow. Securely affix safety-warning labels.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Daikin.

2.2 GENERAL DESCRIPTION

- A. Unit performance and electrical characteristics shall be per the job schedule.
- B. Configuration: Fabricate as detailed on prints and drawings:
 - 1. Return plenum / economizer section
 - 2. Filter section
 - 3. Cooling coil section
 - 4. Supply fan section
 - 5. Gas heating section.
 - 6. Condensing unit section
- C. The complete unit shall be cETLus listed.
- D. The unit shall be ASHRAE 90.1-2016 compliant and labeled.
- E. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.
- F. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

- G. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
- H. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

2.3 CABINET, CASING, AND FRAME

- A. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
- B. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
- C. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- D. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.4 OUTDOOR/RETURN AIR SECTION

- A. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.
- B. Low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.

- C. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when supply fan starts, and close when supply fan stops.

2.5 ENERGY RECOVERY

- A. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- B. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.
- C. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
- D. The unit shall have 2" Merv 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.
- E. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- F. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- G. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- H. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.
- I. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller

shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed.

- J. The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.
- K. The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.6 EXHAUST FAN

- A. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- B. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- C. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.7 FILTERS

- A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

2.8 COOLING COIL

- A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

- B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
- E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.9 HOT GAS REHEAT

- A. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser
- B. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.
- C. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
- D. Each coil shall be factory leak tested with high-pressure air under water.

2.10 SUPPLY FAN

- A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- B. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1" spring isolators.

- C. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
- D. Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
- E. The motor shall be T Frame and open drip proof. Overload protection and speed control is provided by the factory installed VFD and rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- F. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.11 VARIABLE AIR VOLUME CONTROL

- A. An electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the air stream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.
- B. The unit manufacturer shall install all power and control wiring.
- C. The supply air fan drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel.

2.12 HEATING SECTION

- A. The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
- B. The module shall be complete with furnace controller and control valve capable of 12:1 modulating operation.
- C. The heat exchanger tubes shall be constructed of stainless steel.
- D. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
- E. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch

that will prevent the heating module from turning on in the event of no airflow in the flue chamber.

- F. The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

2.13 CONDENSING SECTION

- A. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
- B. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0~120°F. Mechanical cooling shall be provided to 0° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- C. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.
- D. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.
- E. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- F. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

2.14 ELECTRICAL

- A. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be

furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

- B. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

2.15 CONTROLS

- A. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
- B. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
- C. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- D. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
- E. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- F. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
 - 1. Return air temperature.
 - 2. Discharge air temperature.

3. Outdoor air temperature.
4. Space air temperature.
5. Outdoor enthalpy, high/low.
6. Compressor suction temperature and pressure
7. Compressor head pressure and temperature
8. Expansion valve position
9. Condenser fan speed
10. Inverter compressor speed
11. Dirty filter indication.
12. Airflow verification.
13. Cooling status.
14. Control temperature (Changeover).
15. VAV box output status.
16. Cooling status/capacity.
17. Unit status.
18. All time schedules.
19. Active alarms with time and date.
20. Previous alarms with time and date.
21. Optimal start
22. Supply fan and exhaust fan speed.
23. System operating hours.
 - a. Fan
 - b. Exhaust fan
 - c. Cooling
 - d. Individual compressor
 - e. Heating
 - f. Economizer
 - g. Tenant override

G. The user interaction with the keypad shall provide the following:

1. Controls mode
 - a. Off manual
 - b. Auto
 - c. Heat/Cool
 - d. Cool only
 - e. Heat only
 - f. Fan only
2. Occupancy mode
 - a. Auto
 - b. Occupied
 - c. Unoccupied
 - d. Tenant override
3. Unit operation changeover control
 - a. Return air temperature
 - b. Space temperature
 - c. Network signal
4. Cooling and heating change-over temperature with deadband
5. Cooling discharge air temperature (DAT)
6. Supply reset options
 - a. Return air temperature
 - b. Outdoor air temperature

- c. Space temperature
 - d. Airflow (VAV)
 - e. Network signal
 - f. External (0-10 vdc)
 - g. External (0-20 mA)
 - 7. Temperature alarm limits
 - a. High supply air temperature
 - b. Low supply air temperature
 - c. High return air temperature
 - 8. Lockout control for compressors.
 - 9. Compressor interstage timers
 - 10. Night setback and setup space temperature.
 - 11. Building static pressure.
 - 12. Economizer changeover
 - a. Enthalpy
 - b. Drybulb temperature
 - 13. Currently time and date
 - 14. Tenant override time
 - 15. Occupied/unoccupied time schedule
 - 16. One event schedule
 - 17. Holiday dates and duration
 - 18. Adjustable set points
 - 19. Service mode
 - a. Timers normal (all time delays normal)
 - b. Timers fast (all time delays 20 sec)
- H. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:
- 1. Zone sensor with tenant override switch
 - 2. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)
- I. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
- 1. Airflow
 - 2. Outside air temperature
 - 3. Space temperature
 - 4. Return air temperature
 - 5. External signal of 1-5 vdc
 - 6. External signal of 0-20 mA
 - 7. Network signal

2.16 ROOF CURB

- A. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and

condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Comply with manufacture's start-up checklist.

3.2 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
 - 1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
 - 2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7.
 - 3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.
- C. Restrained Curb Support: Install restrained vibration isolation roof-curb rails on roof structure according to "The NRCA Roofing Manual."
- D. Equipment Mounting:
 - 1. Install air units on cast-in-place concrete equipment bases.
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Division 23.
- E. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

- F. Install 3000-psi, compressive-strength (28-day) concrete base inside roof curb, 4 inches thick. Concrete and reinforcement are specified with concrete.
- G. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."
- H. Install separate devices furnished by manufacturer and not factory installed.
- I. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- J. Install drain pipes from unit drain pans to sanitary drain.
 - 1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type M, with soldered joints.
 - 2. Pipe Size: Same size as condensate drain pan connection.

3.3 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Gas Piping Connections:
 - 1. Comply with requirements in Division 22.
 - 2. Connect gas piping to furnace, full size of gas train inlet, and connect with sufficient clearance for burner removal and service.
- C. Duct Connections:
 - 1. Comply with requirements in other Division 23 sections.
 - 2. Drawings indicate the general arrangement of ducts.
 - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Division 23.
- D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 74 33

SECTION 23 81 29

VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes complete variable refrigerant flow (VRF) HVAC systems.

1.2 DEFINITIONS

- A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.
- B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.
- C. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.
- D. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.

1.3 SUBMITTALS

- A. Action Submittals:

- 1. Product Data: For each type of product include:

- a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
- b. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- c. Operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
- d. Description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
- e. System operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.

- f. Description of control software features.
 - g. Total refrigerant required, and a comprehensive breakdown of refrigerant required by each system installed.
 - h. Refrigerant type and data sheets showing compliance with requirements indicated.
 - i. System design software information.
 - j. Indication of location and type of service access.
 - 2. Shop Drawings: For VRF HVAC systems.
 - a. Include plans, elevations, sections, and mounting attachment details.
 - b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. 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.
 - d. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
 - e. Include diagrams for power, signal, and control wiring.
 - 3. Samples for Initial Selection: For fully and partially exposed indoor units with factory finishes viewable by occupants. Include a sample for each unique finish with unit identification, detailed description of application, and cross-referenced floor plans showing locations.
- B. Informational Submittals:
- 1. Qualification Data:
 - a. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation. Retain copies of Installer certificates on-site and make available on request.
 - b. For VRF HVAC system manufacturer.
 - c. For VRF HVAC system provider.
 - 2. Source quality-control reports.
 - 3. Field quality-control reports.
 - 4. Sample Warranties: For manufacturer's warranties.
- C. Closeout Submittals:
- 1. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.
 - 2. Software and Firmware Operational Documentation:
 - a. Software operating and upgrade manuals.

- b. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
 - c. Device address list.
 - d. Printout of software application and graphic screens.
- 3. Extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Filters: One set for each unit.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

- 1. Nationally recognized manufacturer of VRF HVAC systems and products.
- 2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
- 3. VRF HVAC systems and products that have been successfully tested and in use in at least five completed projects.
- 4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
- 5. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

B. Factory-Authorized Service Representative Qualifications:

- 1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
- 2. Demonstrated experience on projects of similar complexity, scope, and value. Each person assigned to Project shall have demonstrated experience.
- 3. Service and maintenance staff assigned to support Project during warranty period.
- 4. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

- 1. Each Installer certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
- 2. Installer certification shall be valid and current for duration of Project.
- 3. Retain copies of Installer certificates on-site and make available on request.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

- F. ASHRAE Compliance: Comply with applicable requirements in:
 - 1. ASHRAE 15.
 - 2. ASHRAE 62.1.
 - 3. ASHRAE/IES 90.1.
 - 4. ASHRAE 135: For control network protocol with remote communication.
- G. UL Compliance: Comply with UL 1995.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean and dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit. Remove and replace products that are wet, moisture damaged, or mold damaged.
- E. Replace installed products damaged during construction.
- F. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressors: 10 years from date of Substantial Completion.
 - b. For Parts, Including Controls: 10 years from date of Substantial Completion.
 - c. For Labor: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HVAC SYSTEM DESCRIPTION

- A. The variable capacity heat recovery air conditioning system shall be a system as specified.
- B. The system shall consist of multiple evaporators, branch selector boxes, REFNET joints and headers, a three-pipe refrigeration distribution system using PID control and variable refrigerant flow condenser unit.
- C. The condenser shall be a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant.
- D. The condensing unit may connect an indoor evaporator nominal capacity up to 200% of the condensing unit nominal capacity. All zones are each capable of operating separately with individual temperature control.
- E. A dedicated hot gas pipe shall be required to ensure optimum heating operation performance.
 - 1. Two-pipe, heat recovery systems utilizing a lower temperature mixed liquid/gas refrigerant to perform heat recovery are not acceptable due to reduced heating capabilities.
- F. The condensing unit shall be able to connect to indoor unit models listed in drawings and shall range in capacity from 5,800 Btu/h to 54,000 Btu/h in accordance with manufacturer's engineering data book detailing each available indoor unit.
 - 1. The indoor units shall be connected to the condensing unit utilizing REFNET specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable for a variable refrigerant system.
- G. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with each branch of the cool/heat selector box. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.
- H. Branch selector boxes:
 - 1. The branch selector boxes shall have the capacity to control up to 290 MBH (cooling) downstream of the branch selector box.
 - 2. Each branch of the branch selector box shall consist of three electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the box and main processor and between the box and indoor units.
 - 3. The branch selector box shall control the operational mode of the subordinate indoor units. The use of three EEV's ensures continuous heating during defrost (multiple condenser systems), no heating impact during changeover and reduced sound levels.
 - 4. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.

2.2 OUTDOOR UNIT SYSTEM DESCRIPTION

- A. Stable Operation – System shall provide stable inverter operation at varied ambient conditions.
- B. No Drain Pan Heater – System shall be capable of heating operation without the need for a drain pan heater. If alternate manufacturer is chosen, an additional drain pan heater shall be provided by the manufacturer.
- C. Auto Changeover – System shall, below the field selected outdoor ambient temperature provide signal to initiate auxiliary or back up heat.
- D. Advanced Zoning - A single system shall provide for up to 64 zones.
- E. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve with up to 2000 positions for independent control.
- F. VFD Inverter Control and Variable Refrigerant Temperature - Each condensing unit shall use high efficiency, variable speed all “inverter” based flash vapor injection compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.
 - 1. Indoor shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.
- G. Configurator software - Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes.
 - 1. If this software is not provided by an alternate manufacturer, for each individual outdoor unit the contractor shall do the settings manually and keep detailed records for future maintenance purposes.
- H. Defrost Heating – Multiple condenser Variable Refrigerant Flow systems shall maintain continuous heating during defrost operation. Reverse cycle (cooling mode) defrost operation shall not be permitted due to the potential reduction in space temperature.
- I. Oil Return Heating – Variable Refrigerant Flow systems shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
- J. Low Ambient Cooling - Each system shall be capable of low ambient cooling operation to -4°FDB (-20°CDB).
- K. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve for independent control.
- L. Flexible Design –
 - 1. Systems shall be capable of up to 540ft of linear piping between the condensing unit and furthest located indoor unit.

2. Systems shall be capable of up to 3,280ft total “one-way” piping in the piping network.
 3. Systems shall have a vertical (height) separation of up to 295ft between the condensing unit and the indoor units.
 4. Systems shall be capable of up to 295ft from the first REFNET / branch point.
 5. The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 200% of the condensing unit nominal capacity.
 6. Systems shall be capable of 98ft vertical separation between indoor units.
 7. Condensing units shall be supported with a fan motor ESP up to 0.32” WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.
- M. Oil return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle.
- N. Simple wiring – Systems shall use 16/18 AWG, 2 wire, stranded, non-shielded and non-polarized daisy chain control wiring.
- O. Each condensing unit shall include a multi-functional digital display that can provide system operation status such as operating refrigerant temperatures, pressures, outdoor electronic expansion valve opening and compressor operation time.
- P. Each condensing unit shall include a service window that can provide easy access to system field settings and operation status without completely removing the condensing unit panel.
- Q. Advanced diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location.
- R. Each condensing unit shall incorporate contacts for electrical demand shedding with optional 3 stage demand control with 12 customizable demand settings.
- S. Advanced controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor units.
- T. Each system shall be capable of integrating with open protocol BACnet, LonWorks and Modbus building management systems.
- U. Low sound levels - Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).

2.3 OUTDOOR UNIT REQUIREMENTS

- A. Performance Conditions:
1. Cooling: Indoor temperature of 80°FDB (26.7°CDB), 67°FWB (19.5°CWB) and outdoor temperature of 95°FDB (35°CDB).
 2. Heating: Indoor temperature of 70°FDB (21.1°CDB) and outdoor temperature of 47°FDB (8.3°CDB), 43°FWB (6.1°CDB).
 3. Equivalent piping length: 25ft

B. Cooling or Cooling Dominant Operation:

1. The standard operating range in cooling or cooling dominant simultaneous cooling/heating will be 23°FDB (-5°CDB) ~ 122°FDB (50°CDB).
2. Cooling mode indoor room temperature range will be 57-77°FDB (13.8 - 25°CWB).
3. Each system as standard shall be capable of onsite reprogramming to allow low ambient cooling operation down to -4°FDB (-20°CDB).

C. Heating or Heating Dominant Operation:

1. The standard operating range in heating or heating dominant simultaneous cooling/heating will be -13° – 61°FDB (-25 – 16°CWB).
 - a. If an alternate equipment manufacturer is selected, the mechanical contractor shall provide, at their own risk and cost, all additional material and labor to meet low ambient operating condition and performance
2. Heating mode indoor room temperature range will be 59°FDB - 80°F DB (15°CDB – 26.7°CDB).

2.4 WIRING:

- A. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
- B. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.
- C. The control wiring maximum lengths shall be as shown below:

	CONDENSER TO INDOOR UNIT	CONDENSER TO CENTRAL CONTROLLER	INDOOR UNIT TO REMOTE CONTROL
CONTROL WIRING LENGTH	6,560ft	3,280ft	1640 ft
WIRE TYPE	16/18 AWG, 2 wire, non-polarity, non-shielded, stranded		

2.5 REFRIGERANT PIPING:

- A. The system shall be capable of refrigerant piping up to 540ft actual or 623ft equivalent from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280ft of piping between the condensing and indoor units with 295 feet maximum vertical difference, without any oil traps or additional components.
- B. REFINET piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance.
 1. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

2.6 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

A. GENERAL:

1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls.
2. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator.
3. High/Low pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.
4. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
5. The connection ratio of indoor units to condensing unit shall be permitted up to 200% of nominal capacity.
6. Each condensing system shall be able to support the connection of up to 64 indoor units dependent on the model of the condensing unit.
7. The sound pressure level standard shall be that value as listed in the engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input.
8. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
9. The condensing unit shall be modular in design and should allow for side-by-side installation.
10. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
11. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
12. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation.
13. The condensing unit shall be capable of heating operation at -13°F wet bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
14. The multiple condenser systems shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

B. UNIT CABINET:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed galvanized steel panels coated with a baked enamel finish.

C. FAN:

1. The condensing unit shall consist of one or more propeller type, direct-drive 600W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a

maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.

3. The condensing unit shall have configurable settings for intermittent fan operation to help minimize snow accumulation on fan blades when the system is off.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. SOUND:

1. Nominal sound pressure levels shall be as shown below.

MODEL NUMBER	SOUND PRESSURE LEVEL dB(A)
REYQ432XAYD*	70

2. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

E. CONDENSER COIL:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins shall be coated with an anti-corrosion hydrophilic blue coating as standard from factory with a salt spray test rating of 1000hr per ASTM B117 test standards.
5. The outdoor coil shall have three-circuit heat exchanger design eliminating the need for a drain pan heater. The lower part of the coil shall be used for inverter cooling and be on or off during operation enhancing the defrost operation.
 - a. An alternate manufacturer must provide a drain pan heater to enable adequate defrosting of the unit in defrost operation.
6. The condensing unit shall be factory equipped with condenser coil guards on all sides.

F. COMPRESSOR:

1. The inverter Flash Vapor injection scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
 - a. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value.
 - 1) Non –inverter-driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
2. The inverter driven compressors in the condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “K-type”.

3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type.
 - a. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 3% to 100%.
5. The compressor's motor shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be mounted on vibration dampening rubber grommets to minimize the transmission of vibration, eliminating the standard need for external spring isolation.
9. In the event of compressor failure, the remaining compressors, if applicable, shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be manually activated to specifically address this condition for single module and manifold systems.
10. In the case of multiple condenser modules, combined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours. When connected to a central control system sequential start is activated for all system on each DIII network.

2.7 BRANCH SELECTOR UNITS

A. GENERAL:

1. The branch selector boxes shall be designed specifically for use with the series of heat recovery system components scheduled.
 - a. The selector boxes shall be factory assembled, wired, and piped.
 - b. The branch controllers must be run tested at the factory.
 - c. The selector boxes must be mounted indoors.
 - d. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.
 - e. The number of connectable indoor units shall be in accordance with manufacturer.

B. UNIT CABINET

1. These units shall have a galvanized steel plate casing.
2. Each cabinet shall house 3 electronic expansion valves for refrigerant control per branch.
3. The cabinet shall contain one subcooling heat exchanger per branch.
4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.
5. Nominal sound pressure levels must be measured and published on the submittals by the manufacturer.
6. REFRIGERANT VALVES:

- a. The unit shall be furnished with 3 electronic expansion valves per branch to control the direction of refrigerant flow. The use of solenoid valves for changeover and pressure equalization shall not be acceptable due to refrigerant noise.
 - b. The refrigerant connections must be of the braze type.
 - c. In multi-port units, each port shall have its own electronic expansion valves. If common expansion/solenoid valves are used, redundancy must be provided.
 - d. Multiple indoor units may be connected to a branch selector box with the use of a REFNET joint provided they are within the capacity range of the branch selector.
7. CONDENSTATE REMOVAL:
- a. The unit shall not require provisions for condensate removal. A safety device or secondary drain pan shall be installed by the mechanical contractor to comply with the applicable mechanical code, if an alternate manufacturer is selected.
8. ELECTRICAL:
- a. The unit shall be capable of operation within the limits of 187 volts to 255 volts.
 - b. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

2.8 INDOOR, CASSETTE, CEILING, MOUNTED UNITS

- A. General: Shall be a round flow ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, direct drive DC (ECM) type fan, for installation into the ceiling cavity equipped with an air panel grill. It shall be available in capacities from 7,500 Btu/h to 48,000 Btu/h. It shall be a round flow air distribution type, fresh white, impact resistant decoration panel, or optional self-cleaning filter panel. The supply air is distributed via four individually motorized louvers. To save energy and optimize occupancy comfort, the indoor unit shall be equipped with built in occupancy sensor and surface temperature sensor. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. The indoor units sound pressure shall range from 30 dB(A) to 45 dB(A) at High speed measured at 5 feet below the unit.
- B. Indoor Unit:
- 1. The unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 - 2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 - 3. Both refrigerant lines shall be insulated from the outdoor unit.
 - 4. The round flow supply air flow can be field modified to 23 different airflow patterns to accommodate various installation configurations including corner installations.

5. Return air shall be through the concentric panel, which includes a resin net, mold resistant, antibacterial filter.
6. The indoor units shall be equipped with a condensate pan with antibacterial treatment and condensate pump. The condensate pump provides up to 33-1/2" of lift from bottom of unit to top of drain piping and has a built in safety shutoff and alarm.
7. The indoor units shall be equipped with a return air thermistor.
8. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
9. The voltage range will be 253 volts maximum and 187 volts minimum.
10. To save energy and optimize occupancy comfort, the indoor unit shall be equipped with built in occupancy sensor and surface temperature sensor.
11. Supplied air shall be directed automatically by four individually controlled louvers.

C. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Four auto-adjusted louvers shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
3. The airflow of the unit shall have the ability to shut down outlets with multiple patterns allowing for simpler installation in irregular spaces.
4. A branch duct knockout shall exist for branch ducting of supply air.
5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.08 to 0.16 HP.
3. The airflow rate shall be available in three manual settings.
4. The DC fan shall be able to automatically adjust the fan speed in 5 speeds based on the space load.
5. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with the high efficiency air filter options.
6. The fan motor shall be thermally protected.

E. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin and antibacterial treatment.
2. Optional high efficiency disposable air filters shall be available.
3. Optional Self-Cleaning Filter Panel, which performs automatic filter cleaning up to once a day, with dust collection box that indicates when to be emptied.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2, or 3-row cross fin copper evaporator coil with up to 21 FPI design completely factory tested.

4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/4 inch outside diameter PVC.
5. A condensate pan with antibacterial treatment shall be located under the coil.
6. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

H. Control:

1. The unit shall have controls provided by manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.

2.9 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

- A. General: Shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, direct-drive DC (ECM) type fan with auto CFM adjustment at commissioning, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be available in capacities from 7,500 Btu/h to 48,000 Btu/h. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8" from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 43 dB(A) at low speed measured 5 feet below the ducted unit.

B. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall be equipped with automatically adjusting external static pressure logic that is selectable during commissioning. This adjusts the airflow based on the installed external static pressure.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet and has a built in safety shutoff and alarm.

5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

C. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

E. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 15 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with an 18-3/8" lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

F. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

G. Control:

1. The unit shall have controls provided by the manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

2.10 SYSTEM CONTROLS

A. Navigation (NAV) Remote Controller

1. The NAV Remote Controller can provide control for all VRV indoor units. The remote controller wiring consist of a non-polar two-wire connection to the indoor unit at terminals P1/P2. The NAV Remote Controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s). The NAV Remote Controller does not need to be addressed.
2. Basic Operation:
 - a. Capable of controlling a group of up to 16 indoor units.
 - b. Controller shall control the following group operations:
 - 1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery & Heat Pump Systems))
 - a) Configure only the essential modes to be selectable – remove unnecessary mode selection(s) from display
 - 2) Independent Cooling and Heating setpoints in the occupied mode
 - a) Dual setpoints (individual Cool and Heat setpoints with minimum setpoint differential 0 – 8oF default 2oF (1oC)) or Single setpoint
 - c. Independent Cooling Setup and Heating Setback setpoints in the unoccupied mode
 - d. Fan Speed
 - e. Airflow direction (dependent on indoor unit type).
 - f. The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
 - g. Function button lockout (On/Off, Mode, Fan Speed, Up/Down, Left, Right Arrows)
 - h. Optional Controller Face Decal (BRC1E72RM, BRC1E72RF, BRC1E72RMF, BRC1E72RM2, BRC1E72RF2, BRC1E72RMF2) to hide unnecessary (locked out) buttons
 - i. Indoor Unit group assignment
 - j. Filter indicator
 - 1) Filter service indicator displayed after 100 or 2500 (default) hours of run time configurable via field setting
 - k. Clock (12/24 hour) and Day display
 - l. Automatic adjustment for Day Light Savings Time (DST)
 - 1) Set changeover period (second Sunday in March / first Sunday in November)

B. Intelligent Touch Manager (iTM)

1. Capable of controlling by Area(s) or Group(s)
2. Controller shall control the following group operations:
3. On/Off
4. Operation Mode (Cool, Heat, Fan, Dry, and Auto)
5. Independent Cool and Heat dual Setpoints or single Setpoint for current mode in the occupied period
6. Controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating based upon the Area or Group configurations
7. Independent Setup (Cooling) and Setback (Heating) setpoints in the unoccupied mode adjustable to 50 - 95°F

8. Setup and Setback setpoints can only be set outside of the occupied setpoint range
9. The Setup and Setback setpoints will automatically maintain a 2°F fixed differential from the highest possible occupied setpoints
10. The recovery differential shall be 4°F (default) and adjustable between 2 – 10°F
11. Settings shall be applied based upon the Area or Group configurations
12. Fan Speed
13. Up to 3 speeds (dependent upon indoor unit type)
14. Airflow direction (dependent upon indoor unit type)
15. 5 fixed positions or oscillating
16. Remote controller permit/prohibit of On/Off, Mode, and Setpoint
17. Lock out setting for Intelligent Touch Manager display
18. Indoor unit Group/Area assignment
19. Capable of providing battery backup power for the clock at least 1 year when no AC power is applied.
20. The battery can last at least 13 years when AC power is applied
21. Settings stored in non-volatile memory

C. BACnet Server Gateway Option

1. The iTM BACnet Server Gateway Option shall be capable of making the intelligent Touch Manager work as a BACnet gateway using the BACnet/IP protocol. The iTM BACnet Server Gateway Option shall be capable of exposing indoor unit management points and indoor/outdoor unit operation data as BACnet objects to the BMS. The iTM BACnet Server/Gateway Option shall be capable of allowing the BMS to monitor and/or control indoor units and outdoor units via BACnet objects.
2. The iTM BACnet Server Gateway Option shall support VRV, SkyAir, Outdoor Air Processing Unit, Mini-Split system with use of KRP928, and FFQ indoor unit for Multi-split system.
3. The iTM BACnet Server Gateway Option shall support operation data for VRV IDUs only (requires Airnet addressing)
4. The iTM BACnet Server Gateway Option shall support operation data for the following VRV IV outdoor units: RXYQ_TATJU, RXYQ_TAYDU, REYQ_TATJU, REYQ_TAYDU (requires Airnet addressing).
5. Functions:
 - a. The iTM BACnet Server Gateway Option shall be capable of supporting Change of Value (COV) notification.
 - b. The iTM BACnet Server Gateway Option shall communicate to BMS using port number 47808 (configurable).
 - c. The iTM BACnet Server Gateway Option shall function as BACnet router to provide unique virtual BACnet device identification number (ID) for every indoor unit group address and every outdoor unit device.
 - d. The iTM BACnet Server Gateway Option shall provide configurable BACnet Network number.
 - e. The iTM BACnet Server Gateway Option shall be capable of being configured as a foreign device. It shall be capable of communicating across BACnet Broadcast Management Devices (BBMD) in different subnet networks.
 - f. The iTM BACnet Server Gateway Option shall be run in environments with BACnet communication traffic up to 100 packets/second.

- g. The iTM BACnet Server Gateway Option functions shall be configurable through CSV file which shall be downloaded from iTM and configured by trained personnel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.
- C. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

- A. Service Access:
 - 1. Maintain manufacturer's recommended clearances for service and maintenance.
 - 2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations.
 - 3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
 - 4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
- B. Equipment Restraint Installation: Install equipment with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 23.

3.3 INSTALLATION OF INDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.
- C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

- D. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
- E. In rooms without ceilings, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
- F. Provide lateral bracing if needed to limit movement of suspended units.
- G. Attachment: Install hardware for proper attachment to supported equipment.

3.4 INSTALLATION OF OUTDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Install outdoor units on support structures indicated on Drawings.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved.
- B. Where installing piping and tubing adjacent to equipment, allow space for service and maintenance.
- C. Install piping and tubing in concealed locations unless otherwise indicated except in equipment rooms and service areas.

3.6 ELECTRICAL INSTALLATION

- A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.
- B. Comply with Division 26 for wiring, grounding, and bonding connections.

3.7 INSTALLATION OF SYSTEM CONTROL CABLE

- A. Conform to Division 23 and 28 requirements.

3.8 IDENTIFICATION

- A. Identify system equipment. Comply with requirements for identification specified in Division 23.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to perform manufacturer's recommended testing and to observe and inspect components, assemblies, and equipment installations, including controls and connections.
- B. Products will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 STARTUP SERVICE

- A. Engage a VRF HVAC system manufacturer's service representative to perform systems startup service.
 - 1. Service representative shall be an employee or a factory-trained and -authorized service representative of VRF system manufacturer.
 - 2. Complete startup service of each separate system.
 - 3. Complete system startup service according to manufacturer's written instructions.
- B. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service. Installer shall correct deficiencies found during startup service for reverification.
- C. System Operation Report:
 - 1. After completion of startup service, manufacturer shall issue a report for each separate system.
 - 2. Report shall include documentation describing each startup check, the result, and any corrective action required.
 - 3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference. All available system operating parameters shall be included in the information submitted.

3.11 ADJUSTING

- A. Adjust equipment and components to function in accordance with manufacturer's recommendations.
- B. Lubricate equipment as recommended by manufacturer.
- C. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
- D. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

- E. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.12 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of system Installer. Include four service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.13 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software. Provide upgrade notice at least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.14 DEMONSTRATION

- A. Engage a VRF HVAC system manufacturer's employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system. Perform not less than eight total hours of training.
- B. Location: Owner shall provide a suitable on-site location to host classroom training.
- C. Training Materials: Provide training materials in electronic format to each attendee.
 - 1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.
- D. Acceptance: Obtain written acceptance from Owner's representative that training is complete, and requirements indicated have been satisfied.

END OF SECTION 23 81 29

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SECTION 23 82 36

FINNED-TUBE RADIATION HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes electric baseboard radiation heaters.

1.2 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.
 - a. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings:
 - a. Include plans, elevations, sections, and details.
 - b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Include details and dimensions of custom-fabricated enclosures.
 - d. Indicate location and size of each field connection.
 - e. Indicate location and arrangement of integral controls.
 - f. Include enclosure joints, corner pieces, access doors, and other accessories.
 - g. Include diagrams for power, signal, and control wiring.
 - h. Access door opening size in full open position and resulting space available behind the access door.
3. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.
4. Field quality-control reports.

B. Closeout Submittals:

1. Operation and Maintenance Data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATION HEATERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Berko; Marley Engineered Products.
 - 2. INDEECO.
 - 3. Marley Engineered Products.
 - 4. QMark; Marley Engineered Products.
- B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.
 - 1. 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. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.
- D. Unit Controls: Remote line-voltage thermostat.
- E. Accessories:
 - 1. Filler sections without a heating element matching the adjacent enclosure.
 - 2. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in for electrical connections to verify actual locations before installation of finned-tube radiation heaters.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BASEBOARD RADIATION HEATER INSTALLATION

- A. Install units level and plumb.
- B. Install enclosure continuously around corners, using outside and inside corner fittings.
- C. Join sections with splice plates and filler pieces to provide continuous enclosure.
- D. Install access doors for access to valves.
- E. Install enclosure continuously from wall to wall.
- F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 23 82 36

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SECTION 23 82 39.19

WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 SUBMITTALS

A. Action Submittals:

- 1. Product Data: For each type of product.
 - a. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- 2. Shop Drawings:
 - a. Include plans, elevations, sections, and details.
 - b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - d. Wiring Diagrams: Power, signal, and control wiring.

B. Closeout Submittals:

- 1. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design.
 - 1. Berko; Marley Engineered Products.
 - 2. INDEECO.

3. Markel Products; TPI Corporation.
4. QMark; Marley Engineered Products.
5. Trane.

2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

- A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated. Comply with requirements in other Division 23 Sections.

2.6 CONTROLS

- A. Controls: Through the Building Automation System.

- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Ground equipment according to Division 26.
- D. Connect wiring according to Division 26.

END OF SECTION 23 82 39.19

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SECTION 26 00 10

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes:
 - 1. Descriptions
 - 2. Quality Assurance
 - 3. Record and Information Manuals
 - 4. Examination of Site
 - 5. Warranty
 - 6. Definitions
 - 7. Load Balancing
 - 8. Scheduling
 - 9. Coordination Between Trades
 - 10. Coordination with Utility Companies
 - 11. Owner Furnished Equipment
 - 12. Materials and Equipment
 - 13. Approved Equals
 - 14. Installation
 - 15. Painting and Related Work
 - 16. Cutting, Patching, and Openings
 - 17. Tests
 - 18. Temporary Power
 - 19. Cleaning
- B. This Section applies to all sections of Division 26, 27, and 28.
- C. All applicable requirements of other portions of the Contract Documents apply to the work of all sections of Division 26, 27, and 28, including, but not limited to, Division 01, General Requirements.

1.2 DESCRIPTIONS

- A. The Contractor shall provide the labor, tools, equipment, and materials necessary to complete and leave ready for operation all electrical systems as called for in these specifications or shown on the drawings and all details essential to complete the work. Items omitted from either the specifications or the drawings, but shown or described in the other trades, and all items necessary to make the electrical system complete and workable shall form a part of the work. No "extras" will be allowed.
- B. By submitting a bid, the Contractor certifies that:
 - 1. He is satisfied that he understands all site conditions that may have an effect on his bid price.

2. He fully understands the make-up, construction, and operation of all systems and equipment he is bidding on, and he has included in his price all materials, supplies, accessories, and services necessary to make these systems complete and operational.
- C. Extent of Work: Work under this contract consists of furnishing, installing, testing, placing into operation, and guaranteeing complete electrical systems as shown on the drawings and as specified in Division 26, 27, & 28. The Contractor shall connect and place all wired equipment in proper working order. Refer to the plans and specifications for work included in this Contract. Some general guidelines to coordinating work between Division 26 and other Divisions are as follows:
1. Division 26 includes all power wiring and raceways for other Divisions' equipment. Division 26 is responsible to furnish and install motor starters and disconnect switches for Division 21, 22 and Division 23 equipment, unless otherwise noted. Remote two wire control logic will be extended to the motor starters as work of other Divisions. Where combined line voltage power/control is used for Division 21, 22 or Division 23 equipment, the wiring and raceways are treated as power wiring and are work of Division 26.
 2. Division 26 is responsible for providing appropriate wire and conduit between all distribution equipment and all electrical devices and utilization equipment shown on plans. It is also the responsibility of Division 26 to provide all wire, conduit, and devices necessary to accomplish all control functions as indicated by the control diagrams which are not specifically shown as work of another division.
- D. Abbreviations used in these specifications:
1. ADA - Americans with Disabilities Act
 2. ANSI - American National Standards Institute
 3. ASTM - ASTM International
 4. CBM - Certified Ballast Manufacturers
 5. EIA- Electronic Industries Association
 6. ETL - Electrical Testing Laboratories
 7. FCC - Federal Communications Commission
 8. ICEA - Insulated Cable Engineers Association
 9. IEC - International Electro Technical Commission
 10. IES - Illuminating Engineering Society
 11. IEEE - Institute of Electrical and Electronics Engineers
 12. ITL - Independent Testing Laboratories
 13. NEC - National Electrical Code
 14. NECA - National Electrical Contractors Association
 15. NEMA - National Electrical Manufacturer's Association
 16. NESC - National Electrical Safety Code
 17. UL - Underwriters Laboratories
 18. A/E - Architect of Record or Engineer of Record

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform all work in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

1. All work shall be installed in full accordance with the latest edition of the National Electrical Code (NEC) as prepared and published by the National Fire Protection Association (NFPA) and any applicable local or state codes. All electrical equipment shall be listed and labeled by Underwriters' Laboratories, Inc. (UL) or any approved independent nationally recognized electrical testing laboratory where such standards exist. Optionally, in lieu of such listing and labeling, equipment preapproved by the Electrical Inspector may be supplied. Wherever UL compliance is mentioned in the specifications, the above alternatives shall be understood to apply to all listing and labeling requirements. This does not preempt or replace the specifications or replace the approval process. All service switches/circuit breakers shall be listed and labeled as outlined above for service entrance duty.
2. Comply with the requirements of NFPA Code 241 "Building Construction and Demolition Operations," the American National Standards Institute (ANSI) A10 Series standards for "Safety Requirements for Construction and Demolition," and the National Electrical Contractors Association (NECA) National Joint Guideline NJG-6 "Temporary Job Utilities and Services."
3. In addition to the requirements outlined under other sections of the Contract Documents, all Work, material, and equipment shall comply with all requirements of the latest editions and interim amendments of the National Electrical Safety Code, National Fire Protection Association, OSHA, the building Owner's insurance company, and all applicable federal, state, and local laws and ordinances. All materials shall be listed and labeled by UL and installed as required by the listing.
4. Should any changes in the Drawings or the Project Manual be required to conform to the above regulations, the Contractor shall notify the A/E at the time of submitting his bid. After entering the Owner-Contractor Agreement, the Contractor shall be held to complete all Work necessary to meet these requirements without additional expense to the Owner.

B. Permits and Regulations

1. The Contractor shall obtain all permits and inspections required by laws, ordinances, rules, regulations, and public authority having jurisdiction. The Contractor shall obtain certificates of such inspections and shall submit same to the A/E. The **Contractor** shall pay all fees, charges, and expenses in connection therewith. The Contractor shall furnish to the Owner a certificate of final inspection from the proper authority prior to final payment. Obtain and pay for easements required to bring temporary utilities to the site, where the Owner's easement cannot be utilized for that purpose.
2. The Contractor shall not allow or cause any of the Work to be covered up or enclosed until the A/E or Owner has been notified and given reasonable opportunity (2 working days) to review the Work. When required by law or regulations, the governmental agency having jurisdiction for inspections shall be given reasonable notice and opportunity to inspect the Work. Any Work that is enclosed or covered up before such inspection and test shall be uncovered at the Contractor's expense; after it has been inspected, the Contractor shall restore the Work to its original condition at his own expense.

C. Interpretation of Drawings and Project Manual

1. Any discrepancies between Drawings, Project Manual, Drawings and Project Manual, or within Drawings and Project Manual shall be promptly brought to the

attention of the A/E for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the A/E during the bidding period or of any error on the Contractor's part.

2. The locations of switch, receptacle, light, motor, outlets, etc. shown on Drawings are approximate. The Contractor shall use good judgment in placing the preceding to eliminate all interference with ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the A/E.
3. Check all door swings so that light switches are not located behind doors. Relocate switches as required, with A/E's review.
4. All general trades and mechanical Drawings shall be checked by the Contractor before installing any outlets, power wiring, etc.
5. Equipment sizes and locations shown on the Drawings are estimated. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements, including wire and conduit entrance locations, and install wire, conduit, disconnect switches, motor starters, overload heaters, circuit breakers, or other items of the correct size and locations for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the A/E.
6. The Contractor shall provide all wiring, including disconnect switches and starters for all electrically operated equipment shown on Drawings, specified or required, except that starters and/or disconnect switches need not be furnished where it is specifically noted that they are furnished with the equipment.
7. The Drawings show the general arrangement required for installation of equipment and materials. The Contractor shall follow these Drawings as closely as possible. Should conditions necessitate other arrangements, the Contractor shall prepare and submit drawings showing the changes to the A/E for review before proceeding with the Work.
8. The A/E reserves the right to make minor changes in the location of the installation of equipment and materials up to the time of roughing in at no extra cost to the Owner.
9. The Drawings do not show all offsets and do not detail every point at which unusual conditions of construction may require special attention. All additional fittings, conduits or specialties and other appurtenances necessary due to field conditions shall be provided by the Contractor.
10. In all cases where a device or part of the equipment is herein referred to in the singular number, it is intended that such reference shall apply to as many such devices as are required to complete the installations.
11. Wherever in Division 26, 27, & 28 a Manufacturer is specified with the notation "or approved equal" or "A/E approved", the decision as to the material or equipment being "equal" shall be made by the A/E without exception and this decision shall be accepted by the Contractor as final. Where the Contractor proposes to furnish equipment or material in accordance with the "or approved equal" notation said equipment or materials shall be submitted to the A/E, for review.
12. Elevators: The location of switches, receptacles, lights, telephone outlets, etc., in elevator pits and shafts shall be located as required by the elevator Shop Drawings. Elevator controls shall be interlocked with fire alarm system for elevator recall function and fire fighter control.

1.4 RECORD AND INFORMATION MANUALS

A. Record drawings

1. Prepare record documents in accordance with the requirements in Division 1 Section "Project Closeout." In addition to the requirements specified in Division 1, indicate installed conditions for:
 - a. Raceway systems, size, contents, and location, for both exterior and interior; locations of all concealed utilities; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - b. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - c. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - d. Any deviations made necessary to incorporate equipment different from the Design Base equipment.
 - e. At completion of the project, contractor shall deliver record drawings to the A/E.
2. The Record drawings must be kept current and accurate, and may be reviewed at any time by the A/E or Owner.

B. Operations and Maintenance Manuals

1. Prepare maintenance manuals in accordance with Division 1 Section "Project Closeout." Compile and assemble the operation and maintenance data of equipment specified in Division 26 into a separate set of vinyl covered three ring binders, tabulated and indexed for easy reference. Data shall clearly indicate all options and accessories.
2. The following items, together with any other necessary pertinent data, shall be included in each Manual:
 - a. Each manual shall be labeled on front cover with project name, Contract, Contractor's name, A/E, and date of project completion.
 - b. Manufacturers' names, nearest Factory Representative, and model and serial numbers of components of systems
 - c. Operating instructions, start-up and shut-down procedures
 - d. Maintenance instructions.
 - e. Routine and 24-hour emergency service/repair information:
 - f. Name, address and telephone number of servicing agency
 - g. Names of personnel to be contacted for service arrangements
 - h. Parts list with numbers of replaceable items, including sources of supply
 - i. Manufacturers' literature describing each piece of equipment
 - j. One approved copy of each submittal
 - k. Written warranties
 - l. Certificate of Material Receipt and Certificate of System Completion
 - m. One typewritten directory for each panelboard as installed
 - n. Record (as-built) drawings
 - o. Certificate of Final Inspection signed by Building Authority having jurisdiction
 - p. Test Results
 - q. Coordination analysis (see "Power System Coordination Analysis")
 - r. Video tapes of all equipment demonstrations and training sessions.

3. In addition to the requirements listed above and specified in Division 1, include the following information for equipment items:
 - a. Manufacturers' Descriptive Literature
 - b. Final Signed Submittal Copy of Shop Drawings
 - c. Spare Parts and Replacement Parts Lists
 - d. Manufacturers' Maintenance and Service Manuals
 - e. Project-Specific Description of Operation
 - f. Wiring Diagrams
 - g. Motor list including motor description, motor horsepower, motor voltage, fuse size, fuse type, and overload size.
 - h. Fuse list including fuse location, fuse size, fuse type, and load description.
 - i. Fixture Ballast Schedule
 - j. Lamp Schedule
4. Materials for more than one item shall clearly indicate which item or items are included on the Project.
5. Shop Drawings which are folded and punched for insertion in the Manual shall be such that the Drawings can be unfolded without removing them from the Manual, and all information shall be legible.

1.5 EXAMINATION OF SITE

- A. Certain existing conditions may affect the manner or sequence of the performance of work. Review existing services and structures prior to bidding the work. Review operating schedules for existing systems and services. Coordinate the scheduling of the work with existing operations.
- B. The contractor is encouraged to visit the site of the proposed project. After the contract is signed, no allowance will be made for lack of knowledge of the project conditions.
- C. Verify and reconcile work required by the contract documents with conditions at the site prior to bid.

1.6 WARRANTY

- A. Compile and assemble the warranties specified in Division 26 into a separate set of vinyl covered three ring binders, tabulated and indexed for easy reference.
- B. Provide complete warranty information for each item. Information to include:
 1. Product or equipment list.
 2. Date of beginning of warranty or bond.
 3. Duration of warranty or bond.
 4. Names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.7 DEFINITIONS

- A. Finished Areas: In general, areas with carpet or tile floors, lay-in or fixed ceiling tile, special architectural ceiling treatment, or tiled, plastered, or paneled walls shall be considered finished areas.
- B. Interior: For the purposes of this specification, interior is any area within the boundaries of the foundation of any building within the superstructure or other structures not classified as a building.
- C. Concealed: Embedded in or installed behind walls, within partitions, above suspended ceilings, below grade, in trenches, in tunnels and in crawl spaces.
- D. Exposed: Not installed underground or "concealed" as defined above
- E. Provide: To furnish and install (complete, tested, and ready for operation).
- F. Furnish: To purchase and deliver products to the project site and make ready for installation.
- G. Install: To take furnished products, assemble, erect, secure, connect, and place into operation.
- H. Products: Includes materials, systems and equipment.
- I. Work: The providing of products for entire contract.

1.8 LOAD BALANCING

- A. It shall be the responsibility of the Contractor to balance the loads on the service system, all distribution systems, and all power equipment so that the variation in amperes per phase readings shall not exceed 5% under normal operating conditions.
- B. Special care shall be taken during load balancing to prevent reverse rotation of motors.
- C. If, during load balancing, a load is shifted from one phase to another in a color coded system, the Contractor shall paint or tape the ends of the wire at all outlet points with the proper color code for that phase. Failure to do so shall constitute justifiable grounds to require the Contractor to replace the entire circuit with the proper coded wire at no expense to the A/E or Owner.

1.9 COORDINATION BETWEEN TRADES

- A. General
 - 1. Coordinate all requirements of the Work of this Division with other Trade Contractors. Such requirements include, but are not limited to, locations, sizes, anchors, and similar items.
 - 2. Provide all necessary information to other Trade Contractors for such coordination. Such information shall include conforming Shop Drawings, conforming Product Data, and all other required data.

3. This Contractor shall bear all costs for providing affected Work of related Trade Contractor(s) with no change to the Contract Sum or Date of Substantial Completion.
4. This Contractor shall coordinate all of his/her work with the General Trades Contractor for location of all devices, fixtures and equipment prior to rough-in.

B. Mechanical/Electrical Coordination

1. Plumbing, Fire Protection, HVAC, and Electrical Contractors shall coordinate their rough-in, service, and control requirements with each other. Electrical Contractor shall review all control drawings to coordinate exact number and locations of temperature control panels as well as to provide proper starters (including necessary time delays, auxiliary contacts, etc.).
2. All wiring required to power Plumbing, Fire Protection, or HVAC equipment shall be installed by the Electrical Contractor, including 120 volt to temperature control panels. All control and interlock wiring, regardless of voltage, is by the Contractor furnishing the control panel. The Division 28 Contractor shall be responsible for the wiring from the fire alarm control panel to the control device.
3. All electrical devices furnished as a part of Division 23 equipment, and installation requirements of all electrical work done by Division 23 Contractors shall conform to the applicable sections of Division 26.
4. Electrical Contractor shall coordinate with other Contractors prior to installation of switchboards and panelboards to insure requirements of NEC Articles 110 and 408 are met. The Contractor violating this requirement shall be responsible for the cost of all modifications required to comply to the satisfaction of the inspection agency for failure to meet the above code requirements.
5. If motors and/or equipment are furnished by other Divisions, which require larger starters, safety switches, circuit breakers, fuses, and/or branch circuit conductors than indicated, due to a larger size than specified, the Contractor furnishing the motors shall reimburse the Electrical Contractor for any cost differential.
6. Final operation of equipment provided under other Divisions shall be the responsibility of the other Divisions Contractor.
7. Motorized dampers on exhaust fans shall operate when exhaust fan is energized. Wire dampers to their respective motor leads to energize the damper motor and open the damper when the fan runs. Equipment, including dampers, operator, and transformer (if required) will be furnished by the fan supplier. Motors fed from a variable frequency drive (VFD) shall be served from a separate branch circuit. Provide circuit to serve the dampers from the nearest panelboard (normal or emergency, to match motor). Control circuit through VFD damper control relay.

C. Foundations, Bases, Curbs, and Supports

1. Provide and coordinate all requirements for foundations, bases, curbs, and supports with the related Trade Contractor(s).
2. Provide required dimensions, templates, and all required information on anchors, sleeves, and cast-in-place accessories, including dimensions, to the related Trade Contractor(s).

D. Openings, Recesses, and Chases

1. Coordinate all requirements and locations for openings, recesses, and chases with the related Trade Contractor(s).

E. Final Connections

1. Coordinate with the related Trade Contractor(s) all requirements for rough-in and final connections for equipment installed under this Division.

1.10 COORDINATION WITH UTILITY COMPANIES

A. Description

1. The Division 26 contractor shall:
 - a. Coordinate division of responsibility with the utility companies serving the building.
 - b. Provide, furnish or install materials and labor not provided, furnished or installed by the utility companies.
 - c. **Provide an allowance in the bid for utility aid-to-construction cost as follows:**
 - i. **Electric: \$xxxxx.xx**
 - ii. **Telecom: \$xxxxx.xx**
 - iii. **Cable: \$xxxxx.xx**

B. Division of work-electric power utility

1. In general, the power company will do the following:
 - a. Provide primary riser
 - b. Provide primary cable
 - c. Provide load break connectors
 - d. Provide Terminators
 - e. Provide grounding
 - f. Provide security padlock
 - g. Provide meter
 - h. Furnish meter trim
 - i. Furnish metering transformers
 - j. Provide meter wire from metering transformer to meter
 - k. Provide pad mounted transformer
2. The electrical contractor is responsible for all other work, including the following:
 - a. Provide sleeve for grounding rod
 - b. Install meter trim
 - c. Provide conduit for meter wiring from transformer to meter trim
 - d. Provide protective bollards
 - e. Furnish easement or right-of-way
 - f. Provide concrete pad
 - g. Provide trenching
 - h. Provide primary duct
 - i. Provide secondary duct
 - j. Provide secondary conductors and lugs
 - k. Provide pulling wire, string, or rope, in duct

C. Division of work-Telephone utility

1. In general, the telephone company is responsible for all service cable work, including furnishing and installing main service copper, fiber and coax cables to the building.
2. The electrical contractor is responsible for all other work, including the following:
 - a. Providing trenching and backfill for telecommunications service conduits.

- b. Furnishing and installing telecommunications service conduits.
- c. Provide a minimum of a #6 solid copper ground wire from main building ground to telecommunication plywood backboard location. Provide the service entrance plywood backboard and a 120volt GFCI with TVSS double duplex receptacle.

1.11 OWNER FURNISHED EQUIPMENT

- A. The Contractor shall make all necessary provisions for the Owner furnished equipment.
- B. The Contractor shall remove, receive, store, uncrate, protect, and install the equipment in place, complete with field connections between shipping splits, feeder connections, and all appurtenances required to place the equipment in operation, ready for use. The Contractor shall be responsible for the equipment when received, as if he had purchased the equipment himself.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. New material and equipment; all bearing manufacturer's name, model number, or other identification marking.
- B. Provide standard product; latest design with published properties of manufacturer regularly engaged in production of specified material or equipment for minimum 5 years (unless exempted by A/E).
- C. Unless otherwise scheduled or indicated, equipment of same type in same room must match as to color, finish, and design.
- D. Unless otherwise submitted to and approved by A/E, equipment and its devices must be of same manufacturer; or devices must be approved and warranted by equipment manufacturer.
- E. Whenever the Contractor furnishes equipment or material other than the Design Base Manufacturer specified, the Contractor is responsible for the cost and coordination of all modifications required not only for his work, but also for the work of all other Trades affected. Where changes to other Trades' work are required, this Contractor must include the additional costs of all such work in his bid and ultimately make arrangements with these other Trades for such changes and compensate them accordingly. Where changes to design are required, the Contractor shall submit such changes to the A/E for approval. The Contractor shall investigate potential conflicts such as the following:
 - 1. Provide Physical dimensions and weights
 - 2. Code required working clearances
 - 3. Connecting pipe sizes
 - 4. Additional control and interlock wiring
 - 5. Lug size and quantity

6. Increased wire size, fuse size, and motor control equipment size
7. Increased ventilation requirements
8. Battery capacity
9. Sound levels of audible devices
10. Increased withstand and interrupting ratings of downstream equipment due to differences in over-current protective device characteristics

2.2 APPROVED EQUALS

- A. Equal (equivalent) components (articles, devices, materials, forms of construction, fixtures, etc.) by manufacturers not listed but meeting the specifications may be submitted to the A/E for approval and subsequent inclusion into the bidding documents. Submission must be received no later than 10 working days before bid date. If approved, such manufacturers will be listed in an addendum.
- B. Submittals must include all of the following:
 1. Cover Letter: Company letterhead; addressed to A/E. Indicate the following
 - a. Project name, project number, and phase or bid package if applicable
 - b. Specification Section by number and title
 - c. Specified Product
 - d. Proposed Product
 - e. Deviations, if any, from Specified Product
 - f. List of attachments
 2. Product Data: Manufacturer's literature, fully describing proposed product with exact item highlighted or clearly indicated.
 3. Specifications: Manufacturer's specifications with all modifications noted as required to show compliance with Bidding Documents.
 4. Test Data: Where performance requirements are specified, submit laboratory tests to indicate compliance.
 5. Samples: Submit appropriate samples of proposed product when required by A/E, showing color, texture, construction and other attributes necessary for evaluation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Rough-In
 1. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
 2. Refer to equipment specifications in other Divisions for rough-in requirements.
- B. Electrical Installations
 1. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - a. Coordinate electrical systems, equipment, and materials installation with other building components.
 - b. Verify all dimensions by field measurements.

- c. Coordinate and provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- d. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete or supported from or on other structural components, as they are constructed.
- e. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building and equipment which must be placed in service before further construction can take place.
- f. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- g. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service and place each in proper operating order.
- h. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that the work is shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the A/E before final placement.
- i. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- j. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- k. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.2 PAINTING AND RELATED WORK

- A. Finish painting in areas of new construction is the responsibility of the General Trades Contractor and is specified in Division 9.
- B. Any other painting, required by Sections in Division 26, is the responsibility of the respective Division 26 Contractor. It shall meet the requirements of Division 9. Each Contractor is responsible for repainting of finished areas disturbed by his own cutting and patching.
- C. Factory-finished equipment which has rusted or has been damaged shall be cleaned, spot primed with zinc chromate, and finished to the original quality and color by the Contractor.
- D. Support steel shall be cleaned, rust removed, primed, and painted.

3.3 CUTTING, PATCHING AND OPENINGS

- A. Unless otherwise required in General or Special Conditions, Contractor shall perform all cutting and patching required for his own work. Work must be accomplished in a neat and workmanlike manner, acceptable to the A/E.
- B. If necessary to cut into work of other Trades, it shall be done by other Trades at this Contractor's expense. Patching shall be similarly executed.
- C. Cutting, burning or drilling of structural support beams, joists, plates, or other structural members is strictly prohibited without the specific written consent of the A/E. Use rotary drills where cutting holes through concrete, brick, plaster, or tile is necessary. Obtain approval of the A/E before proceeding with work.
- D. The General Trades Contractor shall locate and size openings for conduit or other items prior to construction.
- E. All cutting and patching shall be done promptly and all repairs shall be made as necessary to leave the entire work in good condition, including all cutting, fitting, and drilling of masonry, concrete, metal, wood, plaster, and other materials as specified or required for proper assembly, fabrication, installation, and completion of all work of the Contract.
- F. Patching shall match adjacent materials and shall be accomplished only by trades men skilled in the respective craft required. Materials and equipment used in the patching work shall comply with requirements of those Sections of the Specification relating to material to be used in new construction.
- G. Electrical provides:
 - 1. All opening and hole information through floors, walls, and roofs for his work; Including all pipe and conduit, inserts, hangers, and plates.
 - 2. Exact information to other contractors as to size, depth, and location of such openings before construction is in place; and delivery and setting in place of all boxes, sleeves, inserts, and forms for his work in time for installation in all locations.
 - 3. All cutting, patching and restoration to accommodate Electrical contractor's failure to provide specified date in time for openings to be left or to accommodate boxes, sleeves, inserts, and forms after construction has been Completed by other contractors.
 - 4. Skilled craftsmen to cut, patch, rebuild, restore, replace, refinish and repaint new construction cut, disturbed, or marred by him to original or new condition; for installation of new, exposed, concealed, underground, or underfloor work of all kinds; for admission of new work and equipment; for installation of new equipment and new work in new construction; for complete restoration of pipe, duct, or equipment covering disturbed or marred by his personnel.

3.4 TESTS

- A. The Contract Documents, laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction may require portions of the work to be inspected, tested, or approved. These services shall be performed by approved agencies.
- B. The A/E must be notified of all scheduled tests and adjustments at least 48 hours before they are scheduled so that he may witness same. If the Contractor performs any test or adjustment without the A/E present, or without proper notification, the Contractor may be required to perform the test or adjustment a second time. All schedules are to be coordinated with the A/E and Owner far enough in advance so-as to minimize inconvenience.
- C. Tests shall include:
 - 1. Proper operation of lights and equipment.
 - 2. Continuity of conduit system.
 - 3. Insulation leakage and impedances.
 - 4. Ground system resistance.
 - 5. Any sub-system tests described in other Sections of these Specifications.
 - 6. Record line voltage at service entrance equipment with all systems operating.
- D. Provide a signed statement that all tests have been performed and have met all requirements as described in other Sections. This signed statement shall be incorporated into the Record and Information Manual.
- E. The Contractor shall bear all costs of such inspections, tests, or approvals.

3.5 TEMPORARY POWER

- A. Provide temporary electrical power to be used for construction purposes by all contractors in accordance with Division 1. Provide all fixtures, wiring, and equipment, and make all connections required for temporary electrical service during the construction period; coordinate all power and lighting requirements with the various trades. Contractor to pay for energy consumption, and any utility company charges to establish service.
 - 1. Temporary Service Panels: Provide a minimum of one 100 ampere rated service panel in a location or locations within 200 feet of all building work areas; include as many such panels as required to meet 200 foot maximum distance. Provide all wiring and raceways required for service connection and branch circuit wiring connecting each panel to the serving utility and to the following electrical loads; obtain all permits required.
 - 2. Lighting: Provide minimum of 5 foot-candles of illumination in all building work areas where construction work is being accomplished; increase illumination to 50 foot-candles for painting, plastering and other interior fine finish work.
 - 3. Outlets: Provide duplex receptacle outlets on 100 foot centers maximum; arrange and locate so that no work area of the building is more than 100 feet from a 120-volt outlet; allow no more than 5 outlets on any 20-ampere circuit.
 - 4. Power Circuit Breaker: Provide one 100-ampere, 208-volt, 3-phase or 240-volt, 1-phase circuit breaker in each panel for power equipment.
- B. Power shall be obtained from the local electrical utility.

3.6 CLEANING

- A. Upon completion of work, all materials and equipment furnished in this contract shall be thoroughly cleaned of dirt, grease, rust, and oil. Prepare for finish painting, where painting is specified.

END OF SECTION 26 00 10

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SECTION 26 00 15

SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes administrative and procedural requirements for submitting shop drawings, product data, color samples, and other miscellaneous submittals.
- B. This section applies to all sections of Division 26, 27 and 28.

1.2 DEFINITIONS

- A. Action Submittals: Written information that requires the Engineer's responsive action. Materials and equipment submitted shall meet all the requirements of the Contract Documents. No materials or equipment shall be ordered until the submittal has been reviewed and processed as "Reviewed for Compliance" or "Conform as Noted" by the Contractor, Architect, and Engineer.
- B. Informational Submittals: Written information that does not require the A/E's review. Information is submitted for record purposes only and will not be reviewed by the A/E. It is the Contractor's responsibility to make sure materials and equipment comply with the Contract Documents prior to ordering. If reviewed however, the submittals may be rejected for non-compliance with the requirements of the Contract Documents.
- C. Reviewed for Compliance: The submittal was reviewed for compliance by the Engineer and the submittal was found to generally conform with the design concept and Contract Documents.
- D. Conform as Noted: The submittal was reviewed for compliance by the Engineer and the submittal was found to generally conform with the design concept and Contract Documents with the exception of the items noted. The items noted by the Engineer must be changed and/or included, however, the submittal should not be resubmitted.
- E. Revise and Resubmit: The submittal was reviewed for compliance by the Engineer and the submittal did not conform with the design concept and Contract Documents. The items noted by the Engineer must be changed or included and the submittal must be resubmitted.
- F. Does Not Conform: The submittal was not reviewed because it is incomplete, inadequate for review, or does not meet the submittal requirements listed in the 'Quality Assurance' section below. The Contractor shall review the submittal requirements and resubmit.

1.3 QUALITY ASSURANCE

- A. The review of shop drawings by the A/E does not relieve the Contractor from his/her responsibility to comply with the project documents nor does it authorize any additional cost. The Contractor remains responsible for details and accuracy, for confirming and correlating all quantities, dimensions and weights, for selecting fabrication processes, for techniques of assembly, for performing his/her work in a safe manner and for all coordination of the work with all trades.
- B. Contractor assumes complete responsibility for changes required and contract delays, including that of other trades, as a result of his/her chosen materials and equipment.
- C. All submittals shall bear the Contractor's certification that he/she has reviewed, checked, and approved the submittal, that they have been coordinated with the requirements of the project and the provisions of the Contract Documents, and ~~the~~that he/she has verified all field measurements and construction criteria, materials, catalog numbers, and similar data. Submittals without a Contractor's approval will not be reviewed, will not be returned, and the Contractor will be notified.
- D. Submittals shall identify the manufacturer, specific model number, performance data, electrical characteristics, overall size, features, specified options, wiring diagrams, and any other information necessary to determine if the product or equipment conforms with the contract documents. Contractor shall submit only material applicable for the project, where catalog pages are submitted the contractor shall identify the specific items that apply. Additional equipment specific requirements may be listed in other spec sections.
- E. Submittals shall include the complete package of equipment materials, piping, and insulation pertaining to that piece of equipment. A package of equipment requiring long lead times should be submitted as early as possible.
- F. Where other specification sections require field quality control reports to be prepared by a Qualified Testing Agency, submit testing agency qualification as part of the Informational Submittals. Testing Agency shall be a member company of NETA or an NRTL.
- G. All submittals must be issued individually by specification section.
- H. Submittals which do not conform with the requirements above **WILL NOT BE REVIEWED**; they will be returned to the Contractor marked "Does Not Conform".

1.4 SHOP DRAWING SUBMITTAL PROCEDURES

- A. Electronic copies of the Contract Documents are available from the A/E for Contractor's use in preparing submittals.
- B. Contractor shall submit electronic copies of all shop drawings in PDF format. Electronic submittals shall be emailed to submittals@aecmep.com and the AEC Project Manager. Other means of file transmission such as FTP or other file format types shall be mutually agreed upon.

- C. Contractor shall prepare a title page for each submittal containing the following information:
 - 1. Indicate name of firm and individual with contact information for entity that prepared each submittal.
 - 2. Project name as listed on contract.
 - 3. Specification section number and title.
 - 4. Material or Equipment specified.
 - 5. Date.

PART 2 - PRODUCTS

2.1 SHOP DRAWING SUBMITTALS REQUIRED

- A. Submit information for all equipment described in the specifications and on the drawings.

2.2 INFORMATION SUBMITTALS

- A. Equipment specific information submittals are listed within equipment specification sections. General information submittal requirements are listed below. Information submittals shall be provided when indicated within equipment specifications sections.
 - 1. Qualification Data: For qualified testing agency
 - 2. Seismic Qualification Data: Certificates, for equipment, accessories, and components, from manufacturer.
 - 3. Source quality-control reports.
 - 4. Field quality-control reports.

2.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Provide all information in bound 3-ring binder as well as digital format. Include the following information:
 - 1. All approved shop drawings.
 - 2. All information submittal information.
 - 3. Contractor's warranty and any specific equipment warranty provided by equipment manufacturers.
 - 4. Inspection certificates.
 - 5. Routine maintenance requirements and maintenance intervals for installed components as well as the name and address of qualified service agencies for all major equipment.
 - 6. Manufacturer's written instructions for testing and adjusting equipment.
 - 7. Spare parts list.
- B. Project close-out material: Provide as described in Division 01.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Notify the A/E in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents. The Contractor must boldly note all deviations on the submittal.
- B. Make submittals promptly in accordance with the approved schedule and in such sequence as to cause no delay in the work of the Contractor or any other Contractor.
- C. Correct or change and then resubmit rejected submittals as required until approved. The Contractor must clearly note all revisions on resubmitted submittals. Resubmittals without the revisions noted may be returned without review.
- D. Do not begin fabrication or work that requires an Action Submittal until submittal is processed as "Reviewed for Compliance" or "Conform as Noted" by the A/E.

END OF SECTION 26 00 15

SECTION 26 00 20

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes:
 - 1. Sleeves
 - 2. Seals
 - a. Watertight Seals
 - b. Fire Rated Seals
 - 3. Firestops
 - 4. Concrete
 - 5. Access Panels
 - 6. Coordination Drawings
- B. This Section applies to all sections of Division 26, 27, and 28.

1.2 SUBMITTAL

- A. Action Submittals:
 - 1. Manufacturer's product data sheets indicating product characteristics, performance and limiting criteria
 - 2. Manufacturer's installation instruction for each type of seal or firestop required by the project
 - 3. Written certification that firestopping systems meet firestopping requirements specified herein
 - 4. Concrete compression testing reports

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform all work associated with basic electrical materials in compliance with applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein. Where provisions of the pertinent codes and standards conflict with this specification, the more stringent provision shall govern.
 - 1. American Institute of Steel Construction (AISC) "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings."
 - 2. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel."
 - 3. National Electrical Code (NEC).

1.4 COORDINATION

- A. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Field verify and coordinate with the General Trades Contractor all locations and dimensions to ensure that the equipment will be properly located, readily accessible, grouped with other trades equipment as needed, and installed in accordance with all pertinent codes and regulations, the contract documents, and the referenced standards.
- C. The work shall be carefully laid out in advance, and where cutting, drilling, etc., of floors, walls, ceilings, or other surfaces is necessary for the proper installation, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner.
- D. In the event any discrepancies are discovered, immediately notify the A/E in writing. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Seals
 - a. Link-Seal by Thunderline Corporation
 - b. CSD Sealing Systems
 - c. O-Z/Gedney Inc.
 - d. Crouse Hinds
 - e. Appleton
 - 2. Firestopping Materials
 - a. Hilti
 - b. Tremco Sealants & Coatings
 - c. 3M Fire Protection Products
 - d. Dow Corning
 - e. CSD Sealing Systems
 - f. Insta-Foam Products, Inc.
 - g. The Carborundum Co.
 - 3. Access Panels
 - a. Milcor
 - b. Zurn
 - c. Larsen's
 - d. Acudor
 - e. JL
 - f. Nystrom
 - g. Karp

2.2 SLEEVES

- A. Sleeve material through floors and walls shall be machine cut rigid galvanized steel conduit.
- B. Sleeves installed in new construction shall have welded flange at mid-point of sleeve which functions as a water barrier and anchor collar.
- C. At the contractor's option, steel wall sleeves by Link-Seal may be provided.

2.3 SEALS

- A. Modular mechanical type
 - 1. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between conduit and sleeve.
 - 2. Seal assembly shall have steel bolts and nuts and rubber sealing element for service and environment under which assembly will be used. Seal shall have a pressure resistance rating of 20 psig.
- B. Sealing plug type
 - 1. Seals shall consist of two identical piece plugs made of synthetic rubber with one edge flanged, serrated profile on the outside and a series of ridges on the inside which compress and assures a tight seal. Seal shall have a pressure resistance of 15 psig at the plug base and 30 psig at the flange. Rubber grade shall be suitable for the service and environment under which sealing plug will be used.

2.4 WATERTIGHT SEALS

- A. Modular mechanical type watertight seals shall have zinc galvanized bolts and nuts with EPDM rubber sealing element. Seals shall be Link-Seal, Type C.
- B. Sealing plug type watertight seals shall be made of EPDM rubber. Seals shall be by CSD Sealing Systems.

2.5 FIRE RATED SEALS

- A. Modular mechanical type fire seal shall have zinc galvanized bolts and nuts with silicone rubber sealing element which provides a three hour fire resistance rating. Seals shall be Link-Seal, Pyro-Pac, model FS.
- B. Sealing plug type fire rated seals shall be made of FRR rubber for three hour fire resistance rating, Seals shall be by CSD Sealing Systems.

2.6 FIRESTOPS

- A. General
 - 1. Use only firestop products that have been UL 1479, ASTM E-814 tested for specific fire rated construction conditions conforming to construction assembly

type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

2. Cast-in-place firestop devices are installed prior to concrete placement for use with non-combustible and combustible plastic pipe (closed and open piping systems), or electrical cable bundles, penetrating concrete floors.
3. Sealants, foams or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT).
4. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles and plastic pipe.
5. Foams, intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles.
6. Non-curing, re-penetrable intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles.
7. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes.
8. Materials used for complex penetrations shall be made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
9. Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
10. Firestopping materials shall conform to both Flame (F) and Temperature (T) Ratings as tested by nationally accepted test agencies per ASTM E-814 or UL1479 Fire Tests of Through-Penetration Firestops.
 - a. The F rating shall be a minimum of one (1) hour, but not less than the fire resistance rating of the assembly being penetrated.
 - b. Conduct the fire test with a minimum positive pressure differential of 0.01 inches of water column.

2.7 CONCRETE

- A. All concrete work incidentals to the work of Divisions 26, 27, and 28 is the responsibility of the Division 26 contractor. Such concrete includes, but is not limited to:
 1. Encasement of underground raceways where specified in the section "Underground Ducts and Raceways"
 2. Lighting fixture foundations
 3. Service transformer pad
 4. Primary switch concrete pads unless noted otherwise on the Drawings. Coordinate exact pad requirements and location with the Electric Utility Company if they provide the transformer.
 5. Housekeeping pads

2.8 ACCESS PANELS

- A. Furnish ceiling and wall access panels as necessary for access to pull boxes, junction boxes, remote ballasts, electrical equipment, etc., requiring service, adjustment or maintenance.
- B. Access panels are to be turned over to the General Trades Contractor for installation.

C. Ceiling Access Panels

1. Drywall Ceilings: 24" x 24", Milcor Style DW, 16 gauge steel frame with 14 gauge door panel, double acting concealed spring hinges, cylinder lock, prime painted for finish painting with ceiling.
2. Fire-Rated Ceiling: 24" x 24", Milcor fire-rated access door, UL approved, 16 gauge steel frame with 18 gauge recessed door panel, 20 gauge panel sides and 26 gauge panel hat channel, continuous hinge, self-latching cylinder lock, prime painted for finish painting.

D. Wall Access Panels

1. Drywall: 24" x 24", Milcor Style DW, 16 gauge steel frame with 14-gauge door panel, double acting concealed spring hinges, cylinder lock, prime painted for finish painting with wall.
2. Masonry and Tile: 24" x 24", Milcor Style M Standard, 14 gauge steel frame and door panel, concealed spring hinges, cylinder lock, prime painted for finish painting with wall or Style M stainless.
3. Fire-Rated: 24" x 24", Milcor fire-rated access door, UL approved, 1-1/2 hour, Class B rating, 16 gauge steel frame, 20 gauge insulated door panel continuous hinge, automatic door closer, cylinder lock, interior release mechanism, prime painted for finish painting with wall.

2.9 COORDINATION DRAWINGS

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

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access panels.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Engineer indicating

proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

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

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures, duct work, piping, and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. All penetrations through Fire-rated enclosures.
7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger. Include proposed elevation of conduits and raceways.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations. Include elevation of fixtures and devices.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines. Include mounting elevations.
8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 - b. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - c. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.

- d. All penetrations through Fire-rated enclosures.
9. Review: Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Engineer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Engineer will so inform Contractor, who shall make changes as directed and resubmit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sleeves

1. Furnish and install sleeves for all penetrations through masonry and concrete construction, smoke or fire rated separations, and equipment room walls and floors.
2. Carefully coordinate and check locations of sleeves immediately before and after each concrete pour and masonry installation.
3. Give the General Trades Contractor locations and sizes of all openings required for the installation of sleeves before construction of masonry or concrete walls is started. If it becomes necessary to cut into new work because of the failure of this Contractor to notify the General Trades Contractor, then the General Trades Contractor shall do any necessary cutting and patching required at this Contractor's expense.
4. Cut sleeves through walls flush with each surface. Unused sleeves shall extend beyond wall surface, filled with and surrounded by fire barrier materials, and be provided with caps.
5. Cut sleeves 2 inches above finished floors and 3 inches above floors in equipment rooms and shafts. Bottom of sleeve to be cut flush.
6. Core drill holes for sleeves in existing construction.
7. Patching shall be by the General Trades Contractor at this Contractor's expense.
8. Sleeves must be installed plumb with respect to wall.
9. Pack the space between sleeves and conduits or cables with approved fire barrier sealant to maintain fire rating of structure. Fill space around all sleeves leading into exposed areas with material compatible with adjacent construction and finish or fire barrier sealant material to maintain fire rating of the structure.

B. Seals and Firestops

1. Clean surfaces and substrates of dirt, oil, loose materials and other foreign materials which may affect the proper bond or installation of seals and firestops.
2. Do not apply seals and firestops to surfaces previously painted or treated with a sealer curing compound or similar product. Remove coatings as required in compliance with manufacturer's instructions. Provide primers, as required, which conform to manufacturer's recommendations for various substrates and conditions.
3. Follow manufacturer's written instructions for installation of seals and firestops.

4. Install firestops with sufficient pressure to fill seal holes, voids and openings to ensure an effective smoke seal and to maintain the fire resistance rating of the assembly.
5. Tool or trowel exposed surfaces. Remove excess firestop material promptly as work progresses and upon completion.
6. Unused sleeves shall be filled with and surrounded by firestop material. Sleeve ends shall be capped. Blind sealing plugs may be used at Contractor's option.
7. Install watertight seals for all below grade penetrations of conduit into the building.
8. Install fire rated seals in all fire rated walls and floors.
9. Install oil resistant service seals in environment where oils, fuels, solvents and other petroleum - base products are used.
10. Install corrosive service seals in environments where organic materials, acids, alkalis and related chemicals are used.

C. Concrete

1. Provide concrete compression testing for light pole foundations and exterior equipment pads.
2. Do not mount equipment on concrete supports until concrete has had sufficient setting time (seven days minimum).

D. Access Panels

1. Coordinate locations and installation of panels required to permit convenient access to electrical equipment requiring adjustment, service or maintenance. Mark locations of access panels on Record Drawings

3.2 FIELD QUALITY CONTROL

- A. Examine seals and firestops to ensure proper installation and full compliance with this specification. Work shall be accessible until inspection and approval by the applicable code authorities.
- B. Correct unacceptable seals and firestops and provide additional inspection to verify compliance with this specification at no additional cost to the owner.

END OF SECTION 26 00 20

SECTION 26 00 25

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this Section includes, but is not limited to:
 - 1. The removal of all items of existing construction not to remain as a part of the final Project.
 - a. Remove all existing electrical equipment, wiring, and conduit in the areas to be remodeled, in this Project, unless noted otherwise.
 - b. Existing equipment serving other areas, but interfering with the construction, shall be relocated as directed by the A/E or Owner.
 - 2. Any demolition indicated on the Drawings is shown in general to indicate the extent of demolition and is not to be considered as a record drawing of existing conditions. Accordingly, the Contractor shall be responsible for complete demolition of the electrical work indicated including any buried items or any existing items not shown on the Drawings. Before demolition and before submission of proposed methods and operations, the Contractor shall be responsible to obtain for reference any existing record drawings to determine the nature of the existing electrical work to be demolished.
 - 3. Protect existing Work remaining in place.
 - 4. Protect the public.
 - 5. Repair and restore to original condition all items or portions of electrical work which are not noted to be demolished but are damaged by Work under this Contract.
 - 6. In existing areas not otherwise being remodeled but requiring new mechanical or electrical services or new services passing through, coordinate for cutting, patching, removal and replacement of ceilings, walls, floors and/or slabs with the trade requiring access.
 - 7. Coordinate electrical demolition with all other trades.

1.2 FIELD CONDITIONS

- A. General
 - 1. The Owner assumes no responsibility for the actual condition of structures and electrical work to be demolished.
 - 2. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner in so far as practicable. However, variations within the structure may occur by Owner's removal and salvage operations prior to the start of the Demolition Work.
 - 3. Items of salvable value to the Contractor may be removed as the Work progresses. Salvages items must be transported from the Site as they are removed. Storage or sale of removed items on the Site will not be permitted.

- B. Explosives
 - 1. The use of explosives will not be permitted.
- C. Protection
 - 1. Conduct demolition and removal of debris to ensure minimum interference with roads, streets, walks, and other facilities.
 - 2. Do not close or obstruct streets, walks or other facilities without permission from the governing authority. Provide alternate routes around obstructed traffic ways as required by governing regulations.
 - 3. Ensure safe passage of persons around the area of demolition. Conduct operations to prevent injury to adjacent property and persons.
 - 4. Promptly repair damage caused to adjacent facilities at no cost to the Owner.
- D. Utilities
 - 1. Shut-off active utilities
 - a. Where existing electrical service is to be permanently abandoned, shut-off and cap or arrange with proper utility company for shut-off.
 - b. Where existing electrical services are to be rerouted, or reused in new Work, shut-off, cut and install temporary switches to minimize future shut down periods.
 - 2. Existing utilities to remain: Maintain in service and protect against damage.
 - 3. Existing electrical services to be rerouted: Where electrical services remaining in service interfere with demolition or future construction, shut-off, disconnect, remove, relocate and reconnect as shown or required.
 - 4. Shut-down periods:
 - a. Arrange timing of shut-down periods of all in-service utilities with the Owner. Do not shut-down any utility without prior written approval.
 - b. Keep shut-down period to a minimum or use intermittent period as directed. Shut-down periods may require premium time Contractor work.

PART 2 - PRODUCTS

2.1 SALVABLE ITEMS REMOVED BY OWNER

- A. All items of furnishings and equipment not attached to the building or to utilities will be removed by the Owner prior to start of Demolition Work. Coordinate with Owner's representative all items to be salvaged and store on site as directed.

2.2 SALVABLE ITEMS REMOVED BY CONTRACTOR

- A. All lighting fixtures, lamps and materials or equipment of significant value removed shall be turned over to the Owner. All other materials, such as conduit, boxes, wire, etc., shall become the property of the Contractor and shall be removed from the Project Site

2.3 NON-SALVABLE MATERIAL AND FILL

- A. All other materials, equipment, fixtures, and debris become the property of the Contractor and shall be removed from the Site.

PART 3 - EXECUTION

3.1 SCHEDULE

- A. Coordinate and sequence demolition so as not to cause shutdown of Owner operation.
 - 1. Do not proceed with demolition without written authority to proceed signed by the Owner.
- B. Proceed with demolition in a systematic manner and coordinate with all trades involved.

3.2 PROTECTION

- A. Use water sprinkling, temporary enclosures, and other approved methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
 - 1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, pollution and electrical shock.
 - 2. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations, as directed. Return adjacent areas to condition existing prior to the start of the Work.
- B. Do not throw materials from windows or use metal chutes. Use hoists, wheelbarrows, plywood chutes or other acceptable methods.
- C. In removal of existing materials, take care not to damage Work remaining in place, salvable materials, or equipment. Repair or replace any existing construction, materials, or equipment damaged during demolition, to the Owner's satisfaction at no additional cost.
- D. Remove all materials completely and neatly, leaving surfaces smooth and ready for new Work. Sawcut where necessary. Do not use jackhammers as a means of cutting.

3.3 DEMOLITION

- A. Locate demolition equipment so as not to impose excessive loads to supporting walls, floors, roof or framing.
- B. Carefully remove equipment and materials, or fixtures which are to be reused.
- C. Remove all combustible materials from the Site.
- D. Disconnect or shut off service to areas where electrical work is to be removed. Remove all electrical fixtures, equipment and related switches, outlets, conduit and

wiring which are not a part of the final Project in all areas where Work of this Contract is to be performed.

- E. Maintain all existing circuits to items that are to remain in use.
- F. Existing outlets which are to be removed and have conduits rising from the floor slab shall have the conduits cut below floor level. Rework as required to provide feed-through service to other remaining outlets. Pull new wire between remaining outlets affected by feed-through. Patch floor as required to restore to original condition.
- G. All conduits not embedded in concrete shall be removed. Conduits protruding from concrete shall be cut below floor level. Patch floor as required to restore to original condition.
- H. Abandoned outlet boxes in walls to remain shall be closed with blank coverplates. If equipped with devices, the devices shall be removed and the conductors removed to the adjacent outlet or reconnected as required to provide feed-through service.
- I. Panelboards flush in masonry walls shall have their bussing removed and a blank steel plate installed over the panelboard cabinet to cover the entire opening.
- J. Disconnect and remove electrical connections to equipment designated to be removed by other trades.

3.4 RELOCATION

- A. Items designated to be relocated, shall be removed and stored until the construction is ready for their installation.
- B. All lighting fixtures designated to be relocated shall be cleaned and relamped.

3.5 EXISTING EQUIPMENT TO REMAIN

- A. All electrical items and lighting fixtures designated to remain are to be cleaned, in addition, lighting fixtures shall be relamped. All outlet boxes shall have knockout plugs installed in unused openings. All panelboards are to have blank covers installed in unused circuit breaker spaces.
- B. All existing outlets, equipment, and associated wiring and conduit systems which interfere with the work of the General Trades, Structural, Plumbing, Fire Protection, or HVAC Contractors shall be reworked as required to maintain system operation. Relocate conduits where they will not interfere with new work of other trades.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Disposal of hazardous materials (ex: lighting fixture ballasts) shall be in accordance with Federal and State Environmental Protection Agency regulations. A signed statement signifying proper disposal shall be furnished to the Building Owner in the Record and Information Manuals.

- B. Disposal of other materials shall be in accordance with State and Local regulations.
- C. Cleanup
 - 1. Leave inside of building "broom clean" in all areas.
 - 2. Remove barricades as directed.

END OF SECTION 26 00 25

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.2 DEFINITIONS

A. VFD: Variable frequency drive.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Okonite
7. Southwire Incorporated.

B. **Aluminum or Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.**

C. Conductor Insulation:

1. Type THW-2
2. Type THHN-2-THWN-2
3. Type XHHW-2

D. Multiconductor Cable:

1. Type MC metal-sheathed cable, with ground wire. Refer to restrictions for MC cable in sections below.

E. VFD Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
3. Comply with UL requirements for application.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers:

1. AFC Cable Systems, Inc.
2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Wire size shall meet or exceed the overcurrent device ampacity as required by NFPA 70. Where wire size shown on drawings is larger than the apparent ampacity requirements the size shown should prevail to account for voltage drop. The minimum conductor size shall be #12 AWG except for control wiring, which may be #14 AWG.
- B. Conductors: Aluminum feeders may be utilized for No. 4 AWG and larger, only. Copper for feeders and branch circuits smaller than No. 4 AWG. Solid conductors for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance may utilize the following:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
 - 2. Type XHHW-2, single conductors in raceway
- B. Feeders may utilize the following:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
 - 2. Type XHHW-2, single conductors in raceway
- C. Exposed Branch Circuits:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
 - 2. Metal-clad cable, Type MC
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
 - 2. Type XHHW-2, single conductors in raceway
- F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- G. VFD Output Circuits:
 - 1. Type XHHW-2 in metal conduit
 - 2. Type TC-ER cable with braided shield with dual tape shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. MC Cable may be used for branch circuiting to wiring devices provided it is supported properly and run taut. MC must transition to other approved wire types prior to leaving the room it is permitted in. MC may not be used for home-runs.
- B. MC Cable may be used for lighting fixture whips where concealed, no longer than 6'-0", and shall be properly supported.
- C. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- D. All feeder and branch circuits shall be ran with dedicated neutral conductors (shared neutrals not permitted).
- E. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

- F. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- I. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIELD QUALITY CONTROL

- A. Contractor shall perform insulation resistance (IR) tests, commonly called "megger" tests on any feeder or circuit which may have been damaged during installation or where identified as questionable by the Architect or Engineer. Test shall be performed according to standards published by ANSI/NETA.
- B. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.2 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding 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. Instructions for periodic testing and inspection of grounding features.
 - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Comply with UL 467 for grounding and bonding materials and equipment.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. Dossert; AFL Telecommunications LLC.
 - 3. ERICO International Corporation.
 - 4. Fushi Copperweld Inc.
 - 5. Galvan Industries, Inc.; Electrical Products Division, LLC.
 - 6. Harger Lightning and Grounding.
 - 7. ILSCO.
 - 8. Newton Instrument Company.
 - 9. O-Z/Gedney; A Brand of the EGS Electrical Group.
 - 10. Robbins Lightning, Inc.
 - 11. Siemens Power Transmission & Distribution, Inc.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable unless otherwise required by applicable Code or authorities having jurisdiction. Conductors shall be identified by green insulation or by applying green tape at accessible locations.
- B. Bare Copper Conductors: Copper or tinned wire solid or stranded conductors.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, minimum 1/4" by 4 inches by 20 inches and, with 3/8-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.3 CONNECTORS

- A. UL Listed and acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad, 3/4 inch by 10 feet. Provide sectional ground rods as needed.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Grounding Bus: Install in electrical equipment rooms, telecom rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Exothermic welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to all other Ground Rods: Exothermic welded connectors.
 - 5. Connections to Structural Steel: Exothermic welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Grounding electrode shall include, at a minimum, driven rod(s), metallic water piping system, concrete encased reinforcing steel, and structural steel. Install a main bonding jumper between the neutral and ground buses.

3.3 EQUIPMENT GROUNDING

- A. In addition to the complete metal conduit system, install insulated equipment grounding conductors with all feeders and branch circuits. Minimum equipment grounding conductor size shall be #12 AWG.
- B. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- C. Motor frames shall be bonded to the equipment grounding system by an independent ground wire, sized to match the equipment grounding conductor.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at

closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

- C. Ground Rods: Drive rods until tops are 6 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least **three** rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260581 "Manholes, Handholes, and Underground Pull Boxes," and shall be at least 12 inches deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 70 feet apart.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RGC: Rigid Galvanized Conduit.

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Allied Tube & Conduit.
 - b. Eaton's B-Line Series – Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
2. Supports shall be hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Where installed outdoors or subject to corrosion stainless steel supports shall be provided.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

- B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- C. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, metallic raceways may be supported by openings through structure members, as permitted in NFPA 70.
- B. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick. Powder-actuated fasteners may not be used in occupied buildings.
 - 6. To Steel: Welded threaded studs with lock washers and nuts, Beam clamps, or Spring-tension clamps.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
 2. See additional requirements where painting specification are included as part of this project.
 3. Where finish painting is not included in the general trades contract, or when the Electrical Contractor is the sole contractor, provide prime coat and two finish coats of paint to all ferrous metal which is not galvanized.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780 / A780M.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Surface raceways.
 - 5. Boxes, enclosures, and cabinets.
 - 6. Floor boxes and poke-thru devices.

1.2 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. FMC: Flexible Metal conduit.
- C. RGC: Rigid galvanized threaded steel conduit.
- D. HDPE: High Density Polyethelene.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquid-Tight Flexible metal conduit.
- G. RNC: Rigid Nonmetallic Conduit.

PART 2 - PRODUCTS

2.1 CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit.
 - 3. Anamet Electrical, Inc.
 - 4. Carlon
 - 5. Cantex

6. Champion
7. Electri-Flex Company.
8. O-Z/Gedney.
9. Picoma Industries.
10. Republic Conduit.
11. Robroy Industries.
12. Southwire Company.
13. Thomas & Betts Corporation.
14. Western Tube and Conduit Corporation.
15. Wheatland Tube Company.

- B. Listing and Labeling: Conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 CONDUIT TYPES - APPLICATIONS AND RESTRICTIONS:

- A. RGC: Comply with ANSI C80.1 and UL 6.
1. Not to be used in corrosive atmospheres.
- B. RNC: Type PVC Schedule 40, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
1. For use underground, direct buried or encased in concrete.
- C. EMT: Comply with ANSI C80.3 and UL 797.
1. Not to be used underground or where exposed to weather.
 2. Not to be used in utility tunnels or corrosive atmospheres.
- D. FMC: Comply with UL 1; zinc-coated steel or aluminum.
1. For use with fixture whips and lighting fixtures (6' max).
 2. For connections to dynamic equipment and connections to motors in airstream.
 3. For use in existing walls.
- E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
1. For use under raised floors.
 2. For connections to motors except where protection from physical damage is needed (in air stream).
 3. For use in wet locations.

2.3 CONDUIT FITTINGS:

- A. Manufacturers: Subject to compliance with requirements, provide products equal to one of the following.
1. Appleton
 2. Cooper Industries
 3. Efcor
 4. Steel City

5. T&B
 6. By Raceway Manufacturer
 7. or equal.
- B. Metallic fittings shall comply with NEMA FB 1 and UL 514b.
- C. All fittings shall be UL listed for the application.
- D. RGC
1. Conduit Fittings for Hazardous (Classified) Locations: Threaded, comply with UL 886 and NFPA 70. Provide seal-off's where raceway enters hazardous location.
 2. Threaded fittings, malleable iron, with grounding bushing. Cooper Industries #800 series, or equal.
 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- E. RNC (PVC)
1. Fittings shall be of the same material and manufacturer as the raceway, solvent welded type.
 2. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. EMT:
1. Steel fittings, setscrew type, **non-insulated throats**, concrete tight. Cooper Industries #450 series, or equal.
- G. FMC:
1. Non-insulated, malleable iron, clamp type. Cooper industries #700 series or equal
- H. LFMC:
1. Steel or malleable iron. Cooper Industries Liquidator series, LTK series, or equal.
- I. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and include flexible external bonding jumper.
- J. Joint Compound for RGC, IMC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.
- K. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 CONDUIT SIZES

- A. Minimum Raceway Size 3/4-inch trade size.

2.5 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Mono-Systems, Inc.
 - 4. Schneider Electric - Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be NEMA 3R, listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.6 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated ready for field painting to match installed surface. Provide only where specifically called for on the drawings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the Drawings, this shall be considered the Basis-of-Design product.
 - a. Mono-Systems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. Adalet.
 - 2. Eaton
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman.
 - 7. Hubbell Incorporated.
 - 8. Kraloy.
 - 9. Milbank Manufacturing Co.
 - 10. Mono-Systems, Inc.
 - 11. O-Z/Gedney.
 - 12. RACO; Hubbell.
 - 13. Robroy Industries.
 - 14. Spring City Electrical Manufacturing Company.
 - 15. Stahlin Non-Metallic Enclosures.
 - 16. Thomas & Betts Corporation.
 - 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A. Boxes shall be galvanized or plated finish.
- D. Cast-Metal Outlet and Device Boxes: For use in surface mounted applications. Comply with NEMA FB 1, Type FD, with gasketed cover.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
 - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square or octagonal by 2-1/8 inches deep. Provide extension rings as required for recessed boxes.

- J. Gangable boxes are prohibited.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 for indoor application, Type 3R for outdoor applications (unless otherwise noted on drawings), with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, Type 1 for indoor application, Type 3R for outdoor applications (unless otherwise noted on drawings), galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 FLOOR BOXES AND POKE-THRU DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. FSR Inc.
 - 2. Hubbell Incorporated.
 - 3. Kraloy.
 - 4. Mono-Systems, Inc.
 - 5. RACO; Hubbell.
 - 6. Thomas & Betts Corporation.
 - 7. Wiremold / Legrand.
- B. Metal Floor Boxes:
 - 1. Material: Steel, designed for on-grade installation.
 - 2. Type: Fully adjustable, multi-service (power and telecom), multi-gang. Refer to drawings for wiring device quantity and type.
 - 3. Devices shall be concealed beneath cover (recessed type box) or Devices shall be flush mounted on cover (flush type box). Refer to notes on plans.
 - 4. Shape: Rectangular.
 - 5. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 6. Cover: Provide metal cover with finished floor insert.
 - 7. Floor boxes shall be compatible with standard wiring device types and low voltage modular jacks.

C. Poke-Thru Devices:

1. Material: Sheet metal formed device box.
2. Type: Multi-service (power and telecom), multi-gang. Refer to drawings for wiring device quantity and type.
3. Listing and Labeling: Device shall be UL listed and classified for use in fire rated floors.
4. Cover: Provide flush metal cover with modular device outlets.
5. Devices shall be compatible with standard wiring device types and low voltage modular jacks.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install surface raceways only where indicated on Drawings.
- B. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F .
- C. Do not utilize non-ferrous conduit systems or raceway components for motor circuit conductors for variable speed drives. All portions of VFD raceway systems shall be comprised of ferrous materials and provide a continuously grounded pathway to prevent unintentional RF emissions from motor circuit cables.
- D. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- E. Complete raceway installation before starting conductor installation.
- F. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- H. Conduit shall be run overhead unless specifically shown on drawings to run under the slab.
- I. Conceal raceways within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- J. Support conduit within 12 inches of enclosures to which attached.
- K. Raceways Installed Below Slabs:
 1. Where feeders and branch circuits are permitted to run below slabs they should be installed in non-metallic conduit and encased in 3" envelope of concrete. Provide 6" layer of over fill above encasement.
 2. Conduits shall not be installed above the vapor barrier.

3. Transition from RNC-PVC to RGC before rising above floor.
- L. Stub-ups to Above Recessed Ceilings:
1. Use EMT, RMC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to **1-1/4-inch** trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- U. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- V. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- X. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground conduit crossing building expansion joints. Maintain grounding continuity. Refer to architectural plans for locations or expansion joints.
- Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to **top** of box unless otherwise indicated.
- Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- BB. Locate boxes so that cover or plate will not span different building finishes.
- CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- EE. Floor Boxes and Poke-Thru Devices:
 - 1. Provide dummy cover to protect equipment during construction and concrete pour.
 - 2. Unused openings in floor boxes shall be sealed prior to concrete pour.

3.2 CONDUIT SUPPORT

- A. Secure feeder conduit to basic structural elements with galvanized strap hangers and clamps; use of trapeze type hangers is encouraged for multiple conduits where space will permit. Galvanized metal clamps and screws may be used for attaching and supporting branch circuit conduit. Nonmetallic fasteners shall not be used except plastic inserts may be used in concrete for small conduits.

- B. Vertical conduits shall be supported at each floor by clamps.

3.3 ANCHORS AND FASTENERS

- A. Anchors and fasteners shall be of a type designed and intended for use in the base material to which the material support is to be attached and shall be capable of supporting the intended load and withstanding any associated stresses and vibrations.
- B. In general, screws shall be used in wood, masonry anchors on concrete or brick, toggle bolts in hollow walls, and machine screws, bolts or welded studs on steel.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Warning labels and signs.
 - 5. Equipment identification labels.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Self-Adhesive, Self-Laminating Polyester Labels: Write-on, 3-mil thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend. Provide label at each termination point.

2.2 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a black background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Apply only to finished surfaces.

- B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- C. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- D. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.2 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- B. At each junction box and splice box provide pre-printed self-adhesive labels to identify system, voltage, and/or source panel/circuit numbers.
- C. At each wiring device cover plate provide pre-printed self-adhesive labels to identify source panel/circuit numbers.
- D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:
1. Identify system voltage with black letters on an orange background.
 2. Apply to exterior of door, cover, or other access.
 3. For equipment with multiple power or control sources, identify all sources:
 - a. Controls with external control power connections.
- G. Electrical Service Equipment: Electrical service equipment shall be provided with an equipment label identifying the available fault current and date calculation was performed, at the equipment bus.
- H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual.
1. Labeling Instructions:
 - a. Provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - c. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchboards.
 - e. Enclosed switches.
 - f. Enclosed circuit breakers.
 - g. Enclosed controllers.
 - h. Variable-speed controllers.
 - i. Push-button stations.
 - j. Contactors.
 - k. Remote-controlled switches, dimmer modules, and control devices.
 - l. Monitoring and control equipment.
 - m. UPS equipment.

END OF SECTION 26 05 53

SECTION 26 05 81

MANHOLES, HANDHOLES AND UNDERGROUND PULL BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes underground pull boxes.

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Perform all work in compliance with ASTM, and applicable requirements of governing agencies having jurisdiction and in accordance with these plans and as specified herein.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pull Boxes.
 - 1. Quazite by Hubbell
 - 2. Syntertech by Oldcastle
 - 3. MacLean Highline

2.2 MATERIALS

- A. Underground Pull Boxes
 - 1. Underground pull boxes shall be factory fabricated of fiberglass reinforced polymer concrete. Boxes shall be stackable with minimum dimensions:
 - 1. 11" W x 18" L x 16" D, unless otherwise noted on plans.
 - 2. Covers: Provide heavy duty covers, Tier 15 rated for a service load of 15,000 pounds over a 10-inch square area. Covers shall read "Electric", or "Telecom" as indicated. Covers shall be secured with stainless steel penta-head bolts.
 - 3. Openings: Openings shall be provided for duct number and size as indicated on plan.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Provide underground pull boxes of sizes, and shapes as indicated. Determine final grading of ducts as influenced by possible adjustments in other utilities and surface features and discovery of underground obstructions before installing manholes, handholes, and underground pull boxes, **coordinate with Civil Engineer**. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances.

3.2 INSTALLATION OF UNDERGROUND PULL BOXES

- A. Support units on a bed of #8 crushed stone.
- B. Compact backfill as required to set units securely in place. Backfill and grading shall be sloped to drain surface water away from access covers.

END OF SECTION 26 05 81

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Indoor occupancy sensors.
 - 2. Outdoor motion sensors.
- B. This section describes devices that are stand-alone. Refer to drawings and Section 26 09 43 "Relay-Based Lighting Controls" and Division 23 specifications for lighting controls that are tied into the Building Automation System (BAS).

PART 2 - PRODUCTS

2.1 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lutron
 - 2. Cooper Greengate
 - 3. Crestron
 - 4. Acuity nLight
 - 5. Wattstopper
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 - 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 - 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.2 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Lutron Electronics Co., Inc.
 2. Cooper Greengate
 3. Crestron
 4. Sensor Switch, Inc.
 5. Wattstopper
- B. Devices Types: All devices shall be dual-technology (PIR and Ultrasonic) type, unless otherwise noted on drawings or in this specification.
- C. Microphonic detectors are prohibited.
- D. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast/driver load at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
- E. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 3. Switch Rating:
 - a. Line Voltage Units: Not less than 800-VA LED at 120 V.
 - b. Low Voltage Units: Suitable for use with relay-based lighting control system. Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack relay.
 4. Onboard 0-10V dimming control (sinking) with integral rocker switch for adjusting light levels up/down.
- F. General Requirements for Sensors: High-bay occupancy sensor, solid-state unit. The unit is designed to operate with the luminaires indicated.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
 3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
 4. Operating Ambient Conditions: 32 to 149 deg F.
 5. Mounting: Threaded pipe.
 6. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 7. Detector Technology: PIR.
 8. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.
 9. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 22 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- B. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.4 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. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

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SECTION 26 09 43

RELAY-BASED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Networked lighting control panels using control-voltage relays for switching and that are interoperable with BAS.
2. Manual switches and plates.
3. Field-mounted signal sources
4. Cables and wiring

1.2 DEFINITIONS

- A. BAS:** Building automation system.
- B. IP:** Internet protocol.
- C. Monitoring:** Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- D. PC:** Personal computer; sometimes plural as "PCs."
- E. RS-485:** A serial network protocol, similar to RS-232, complying with TIA-485-A.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For each relay panel and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail wiring partition configuration, current, and voltage ratings.
4. Short-circuit current rating of relays.
5. Include diagrams for power, signal, and control wiring.
6. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the network protocol.
- B. Qualification Data: For testing agency.
- C. Field quality-control reports.
- D. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- E. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lighting Control Relays: Equal to ONE (1) percent of amount installed, but no fewer than TWO (2).

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control panels. Any combination of inputs shall be programmable to any number of control relays.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with UL 916.

2.2 PERFORMANCE REQUIREMENTS

- A. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
 - 1. Hardwired Points:
 - a. Monitoring: On-off status.
 - b. Control: On-off, dimming, and time-of-day operation.
 - 2. Communication Interface: Comply with ASHRAE 135. The communication interface shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

2.3 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide the following:
 - 1. Blue Ridge Technologies (No exception)

2.4 NETWORKED LIGHTING CONTROL PANELS

- A. Description: Lighting control panels using mechanically latched relays to control lighting and appliances. The panels shall be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.
- B. Lighting Control Panels:
 - 1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
 - 2. A vertical barrier separating branch circuits from control wiring.

C. Main Control Unit:

1. Ethernet Communications: Comply with TCP/IP protocol. The main control unit shall provide for programming of all control functions of the main and all networked slave lighting control panels including timing, sequencing, and overriding.
2. Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via BAS RS-485 serial networks and Ethernet 10Base-T networks as a native device.
3. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.
 - a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
 - b. Panel summary showing the master and slave panels connected to the controller.
 - c. Controller diagnostic information.
 - d. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens shall also allow direct breaker control and zone overrides.
4. Timing Unit:
 - a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
 - b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
 - c. Schedule periods settable to the minute.
 - d. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
 - e. **TEN** special date periods.
5. Time Synchronization: The timing unit shall be updated not less than every 24 hour(s) with the network time server.
6. Sequencing Control with Override:
 - a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
 - b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
 - d. Override control "blinking warning" shall warn occupants approximately **FIVE** minutes before actuating the off sequence.
 - e. Activity log, storing previous relay operation, including the time and cause of the change of status.
 - f. Download firmware to the latest version offered by manufacturer.

D. Standard Control Unit, Installed in All Lighting Control Panels: Contain electronic controls for programming the operation of the relays in the control panel, contain the

status of relays, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.

1. Electronic control for operating and monitoring individual relays, and display relay on-time.
 2. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.
 3. Integral keypad and digital-display front panel for local setup, including the following:
 - a. Blink notice, time adjustable from software.
 - b. Ability to log and display relay on-time.
 - c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.
- E. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V. Short-circuit current rating shall be not less than 5 kA. Control shall be three-wire 24-V ac or digital control network.
- F. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.
- G. Operator Interface: At the main control unit, provide interface for a tethered connection of a portable PC running MS Windows for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Owner's personnel. That device shall remain the property of Owner.
- H. Software:
1. Menu-driven data entry.
 2. Online and offline programming and editing.
 3. Provide for entry of the room or space designation for the load side of each relay.
 4. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.
 5. Size the software appropriate to the system.

2.5 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary contact, for operating one or more relays and to override automatic controls.
1. Match color and style specified in Section 262726 "Wiring Devices."
 2. Integral **LED** pilot light to indicate when circuit is on.
- B. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."

- C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 FIELD-MOUNTED SIGNAL SOURCES

- A. Daylight Harvesting Switching Controls: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.
- B. Indoor Occupancy Sensors: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than **No. 24** AWG.
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than **No. 14** AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways, cable trays, and/or cable management devices. Conceal raceway and cables except in unfinished spaces. All wiring shall be accessible.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 PANEL INSTALLATION

- A. Comply with NECA 1.
- B. Install panels and accessories according to NECA 407.
- C. Mount top of trim **72 inches** above finished floor unless otherwise indicated.
- D. Mount panel cabinet plumb and rigid without distortion of box.
- E. Install filler plates in unused spaces.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.
- D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 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. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Acceptance Testing Preparation:
 - 1. Test continuity of each circuit.
- D. Lighting control panel will be considered defective if it does not pass tests and inspections.

- E. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform, Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 26 09 43

SECTION 26 24 13

SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Identification.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include schematic and wiring diagrams for power, signal, and control wiring.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Comply with NEMA PB 2.
- D. Comply with NFPA 70.
- E. Comply with UL 891.

1.4 PROJECT CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect/ Construction Manager no fewer than SEVEN days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Architect's, Construction Manager's written permission.
 - 4. Comply with NFPA 70E.

1.5 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D) or comparable product by one of the following:
 - 1. Eaton
 - 2. GE/ABB
 - 3. Siemens
- B. Switchboard shall be free standing, dead front, front-accessibility required. Refer to plans for additional access requirements for each unit; side, rear, front or a combination:

1. Main Devices: Panel Fixed, group mounted.
 2. Branch Devices: Panel mounted.
 3. Sections front and rear aligned.
- C. Indoor Enclosures: Steel, NEMA 250, Type 1.
- D. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- E. Barriers: Between adjacent switchboard sections.
- F. Customer Metering Compartment: A separate customer metering compartment within front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.
1. Provide customer metering as specified in section 26 27 13 – Electricity Metering.
- G. Removable Rear Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- I. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity. Busses shall be full height in each section.
 2. Ground Bus: Hard-drawn copper of 98 percent conductivity.
 3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 4. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- J. Provide factory-installed, integral Surge Protective Device (SPD); labeled by an NRTL for compliance with UL 67 after installing SPD. Provide Type I device as specified in section 26 43 13 - Surge Protection for Low Voltage Electrical Power Circuits. Device shall be front mounted on hinged door, served from a load side overcurrent protective device, coordinate with SPD manufacture for overcurrent protective device size.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, fully rated to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: For circuit-breaker frame sizes up to 100 A, unless otherwise noted.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting. For circuit breaker frame sizes larger than 100A and
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings where shown on drawings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at **75** percent of rated voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

3.2 INSTALLATION

- A. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in other sections.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- C. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- D. Install filler plates in unused spaces of panel-mounted sections.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 1. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Switchboard will be considered defective if it does not pass tests and inspections.

- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 24 13

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 ACTION SUBMITTALS

- A. Product Data:** For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings:** For each panelboard and related equipment.
1. Include dimensioned plans, elevations, and details. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Include evidence of NRTL listing for series rating of installed devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 7. Include wiring diagrams for power, signal, and control wiring.

1.3 QUALITY ASSURANCE

- A. Source Limitations:** Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.**
- D. Comply with NFPA 70.**
- E. Comply with UL 67.**

1.4 COORDINATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect, Construction Manager, no fewer than SEVEN days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Architect's, Construction Manager's, or written permission.
 - 3. Comply with NFPA 70E.
- B. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **FIVE** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. All panelboards shall be rated, listed and labeled for the available short-circuit current by the manufacturer. Minimum interrupting rating of 10,000 amps.
- B. Panelboard Short-Circuit Current Rating: Fully Rated to interrupt symmetrical short-circuit current available at terminals.
- C. Enclosures:
 - 1. Provide flush and surface enclosures as described on the drawings. Each enclosure shall be rated for environmental conditions at installed location.
 - 2. Provide NEMA 3R enclosures, at a minimum, where panelboards are installed outdoors.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 4. Finishes:
 - a. Panels and Trim: Steel with factory enamel finish.
 - b. Panel Tubs: Galvanized steel.

5. Locking type doors with concealed hinges
6. Panel tubs shall be 20" wide x 5" deep, minimum.
7. Directory card mounted inside panelboard door inside a transparent card holder.

D. Phase, Neutral, and Ground Buses:

1. Material: **Aluminum** or **Copper**.
2. Neutral bus (where required) shall be supplied separate from ground Bus.
3. Split Bus: Vertical buses divided into individual vertical sections.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: copper, or CU/AL bi-metallic type.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

F. Where used as service equipment, panelboards shall carry a Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Protective Devices shall be provided for all Emergency panelboards (as defined by NEC article 700), and where indicated on drawings. Devices shall be Type II, as specified in section 26 43 13 - Surge Protection for Low Voltage Electrical Power Circuits. Device shall be remote mounted above or below panel enclosure, served from a load side overcurrent protective device, coordinate with SPD manufacture for overcurrent protective device size. SPD circuit conductor length shall not exceed 18".

1. For service equipment provide Type 1, located ahead of the service disconnect.

2.3 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D), I-Line Style or comparable product by one of the following:

1. Eaton
2. GE/ABB
3. Siemens

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

C. Where main overcurrent protective devices are called for, devices shall be solid-state electronic trip type with LSI adjustable settings.

D. Branch overcurrent protective devices shall be molded case type circuit breakers.

- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D), NQ (240V) or NF (480V) Style or comparable product by one of the following:
 - 1. Eaton
 - 2. General Electric
 - 3. Siemens
- B. Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- C. Contactors in Main Bus: NEMA ICS 2, Class A, electrically, held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. External Control-Power Source: 120-V branch circuit.
- D. Panelboards: With factory-installed, integral Surge Protective Device (SPD); labeled by an NRTL for compliance with UL 67 after installing SPD. Provide Type II device as specified in section 26 43 13, Surge Protection for Low Voltage Electrical Power Circuits.
- E. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- F. Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- G. Buses:
 - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
 - 2. Copper equipment and isolated ground buses.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- B. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Floor set panelboards shall be installed on concrete bases, 4-inch nominal thickness.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
- B. Wall mounted panelboards shall be installed so that the top of the cabinet is 6'-0" above the floor, coordinate panelboard location to avoid interference with other equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box. Assure door swing does not interfere with other equipment.
- E. Install filler plates in unused spaces.
- F. Where panelboards are to be recessed, stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

END OF SECTION 26 24 16

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SECTION 26 27 13

ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes equipment for:
 - 1. Electricity metering by utility company
 - 2. Electricity metering non-utility.

1.2 DEFINITIONS

- A. PC: Personal computer.

1.3 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
 - 1. Comply with requirements of utilities providing electrical power services.
 - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- C. Meter Sockets: Comply with requirements of electrical-power utility company.
- D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

2.2 EQUIPMENT FOR ELECTRICITY METERING NON-UTILITY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D) or comparable product by one of the following:

1. E-Mon; a division of Hunt Power.
 2. Eaton
 3. General Electric
 4. National Meter Industries.
 5. Osaki Meter Sales, Inc.
 6. Siemens
- B. Meter for Switchboard/Panelboard Use: Non-Revenue grade meter suitable for flush mounted installation in door of NEMA 1 switchboard/panelboard enclosure. Provide Schneider Electric # Power Logic PM5500 which includes the following features:
1. Metered/Displayed Values: Voltage, Current, Frequency, Energy, Power factor, Active and reactive power.
 2. Max/Min recording.
 3. Display Type: Backlit LCD
 4. Accuracy: 0.5%, Class 0.5 by IEC 62053-22.
 5. Onboard Memory: 256 KB of time-stamped data recording.
 6. Communication: Meter shall be capable of communicating over ethernet, Modbus, TCP/IP.
- C. All electric meters shall comply with UL 1244.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Connect a load of known kilowatt rating, to a circuit supplied by metered feeder.
 2. Turn off circuits supplied by metered feeder and secure them in off condition.
 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

- B. Electricity metering will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 26 27 13

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI
 - 2. Weather-resistant receptacles.
 - 3. Snap switches.
 - 4. Device cover plates.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.4 ACTION SUBMITTALS

- A. Product data: For each type of device and component indicated. Include manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all wiring devices and associated wall plates from single source from single manufacturer.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper
 - b. Hubbell
 - c. Legrand
 - d. Leviton
 - e. Lutron
 - f. Pass & Seymour

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices shall be side-wired. Devices that use modular plug-in connectors are not acceptable.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 120 volt, 20 amp: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
- B. All convenience and power receptacles shall be Heavy Duty **Specification grade**, grounding type.
- C. Weather resistant Receptacle shall be ultra-violet, corrosion, and impact resistant, with UL approved "WR" marking on face.
- D. Tamper Resistant Receptacles: All 120V and 250V, 20A, non-locking type receptacles shall be installed throughout the facility.
- E. Specialty receptacles shall be as specified on Drawings.
- F. USB Charging Receptacles: Receptacle shall consist of a tamper-resistant duplex convenience receptacle with one USB-A and one USB-C charge port integral in the face of the receptacle. Device shall supply no less than 24W of charging power.

2.4 GFCI RECEPTACLES

- A. General Description:
 1. Straight blade, feed-through type, unless specified otherwise on Drawings.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, and FS W-C-596.
 3. Comply with UL 943, device shall be self-testing and provide visual or audible alarm upon ground fault condition.
 4. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

- B. Weather resistant Receptacle shall be ultra-violet, corrosion, and impact resistant, with UL approved "WR" marking on face.

2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 volt, 20 amp:
- C. Pilot-Light Switches, 20 amp:
 - 1. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."
- D. Key-Operated Switches, 120/277 volt, 20 amp:
 - 1. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 volt, 20 amp; for use with mechanically held lighting contactors.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 volt, 20 amp; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces:
 - a. 0.035-inch- thick, satin-finished, Type 302 stainless steel
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.7 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect/Engineer unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including final painting, is complete.
- C. Conductors:
 - 1. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 2. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 3. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Do not remove surface protection, such as plastic film and smudge covers, until immediately prior to occupancy.
 - 3. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 4. Tighten unused terminal screws on the device.
 - 5. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
 - 1. Devices shall be installed vertically with ground pin down, where explicitly shown to be mounted horizontally, position the ground pin to the right.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. The use of caulk around device plates to seal gaps shall not be permitted.
- G. Adjust mounting height and location of Devices: Where devices are installed to serve furniture or furnishings, or otherwise located in the vicinity of furniture or furnishings, the mounting height and location of such Devices shall be adjusted to permit full access to the Devices without the need to move furniture or furnishings. Provide proposed modifications of mounting height and locations for each Device to be changed to Engineer for approval prior to rough-in of said Device.
- H. Plug-load controlled receptacles shall be controlled on/off using a time-of-day schedule. Refer to plans for specific control requirements.

3.2 WEATHER RESISTANT RECEPTACLES

- A. All 120 volt, 20 amp receptacles installed in damp or wet locations shall be UL listed as weather-resistant and have "WR" mark on face of receptacle. Receptacles installed outside shall be provided with a weather-proof "in-use" cover.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value over 5 percent is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device shall be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 26

SECTION 26 27 43

ELECTRIC-VEHICLE SERVICE EQUIPMENT - AC LEVEL 2

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 EVSE that provides AC Level 2 EV charging.

1.3 DEFINITIONS

- A. EV: Electric vehicle.
- B. EV Cable: The off-board cable containing the conductor(s) to connect the EV power controller to the EV that provides both power and communications during energy transfer.
- C. EV Charger or EV Charging Equipment: See "EVSE."
- D. EV Connector: A conductive device that, when electrically coupled to an EV inlet, establishes an electrical connection to the EV for the purpose of power transfer and information exchange. This device is part of the EV coupler.
- E. EV Coupler: A mating EV inlet and connector set.
- F. EV Inlet: The device in the vehicle into which the EV connector is inserted, and a conductive connection is made for the transfer of power and communication. This device is part of the EV coupler.
- G. EVSE: Electric-Vehicle Supply Equipment. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premise wiring and the EV.

1.4 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for EV charging equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For EVSE.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 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.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EVSE that fail(s) in materials or workmanship within specified warranty period.
1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Charge Point or comparable product by one of the following:
- B. Level 2 Charging Station:
1. Hubbell
 2. Legrand
 3. Square D (Schneider Electric)
 4. Leviton
 5. Blink

2.2 REQUIREMENTS

- A. Ambient Temperature: 5 to 104 deg F.
- B. Relative Humidity: Zero to 95 percent.
- C. Surge Withstand: 6 kV at 3000 A.

- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- E. EV Charging Levels:
 - 1. Dual cord, AC Level 2 at up to 8.0 kW per vehicle.

2.3 EVSE DESCRIPTION

- A. Comply with NFPA 70.
- B. Comply with:
 - 1. UL 2231-1.
 - 2. UL 2594.
 - 3. SAE J1772 for SAE combo chargers.
- C. Comply with ADA-ABA Accessibility Guidelines.
- D. Metering: Revenue grade meter.
- E. Control Power: 110/120-V ac, 60 Hz, single phase per charger. Control power shall be derived from integral transformer.
- F. Input Power: 40 A, 208/240-V ac, 60 Hz, single-phase services per charger. Power share dual cord equipment where a single power feed to a single charger serves two vehicles.
- G. Integral GFCI.
- H. Auto-GFCI fault retry.
- I. EVSE Mounting: Bollard mount.
- J. Enclosures:
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: Type 3R.
 - b. Lockable.
 - c. Tamper resistant.
- K. EV Cable and Connectors:
 - 1. SAE J1772 connector.
 - 2. Single connectors.
 - 3. 18-foot cable with cable management system.
 - 4. Field-replaceable connector and cable assembly.
- L. Status Indicators:
 - 1. LEDs to indicate power, charging, charging complete, system status, faults, and service.

M. Display Screen:

1. Daylight viewable, UV-protected display with human-machine interface capability.
2. Displays power, charging, charging complete, remote control, system status, faults, and service.

N. Networking:

1. LAN Communications: 802.11b/g/n
2. Capable of remote configuration and reporting.

O. Payment System:

1. RFID reader.
2. PCI compliant.
3. Capable of remote control and authorization.

2.4 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by utilizing cushioning materials or foam or by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1 and NECA 413.
- B. Concrete Base Mounting:
1. Install EVSE on 12-inch nominal-diameter and 48-inch- deep concrete base. Comply with requirements for concrete base.
 - a. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - c. Secure EVSE to concrete base according to manufacturer's written instructions.
- C. Cybersecurity:
1. Software:

- a. Coordinate security requirements with University OCIO.
- b. Ensure that latest stable software release is installed and properly operating.
- c. Disable or change default passwords to password of at least eight characters in length, using a combination of uppercase and lower letters, numbers, and symbols. Record passwords and turn over to party responsible for system operation and administration.

3.2 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

END OF SECTION 26 27 43

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SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in the following:
 - a. Enclosed switches and controllers.
 - b. Exterior lighting fuses.

1.2 CLOSEOUT SUBMITTALS

1. Spare Parts Inventory List

1.3 QUALITY ASSURANCE

- ###### **A. Source Limitations:** Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

PART 2 - PRODUCTS

2.1 FUSES

- ###### **A. Basis-of-Design Product:** Subject to compliance with requirements, provide Cooper Bussman or comparable product by one of the following:

1. Cartridge Fuses
 - a. Mersen
 - b. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- ###### **A. Characteristics:** Fuses shall be current-limiting with 200,000 Amps interrupting rating and carry a UL label.
1. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting; 600V – LP-CC
 2. Type J: 600-V, zero- to 600-A rating, 200 kAIC; 600V – JDL.
 3. Type RK1: Thru 600A, 200 kAIC, dual element, time delay; 250V – LPN-RK, 600V – LPS-RK.

2.3 SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to **10** percent of the quantity installed for each size and type, but no fewer than **two** of each size and type.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Within each fusible device, install fuses that are of the same class and rating. Do not mix class or amperage ratings between multiple fuse positions.

3.2 IDENTIFICATION

- A. Install labels complying with requirements for identification specified elsewhere and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Disconnect switches.
 - 2. Molded-case circuit breakers (MCCBs).

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Eaton
 - 2. GE/ABB
 - 3. Siemens
 - 4. Schneider Electric (Square D).
- B. Type HD, heavy duty, fusible and non-fusible, disconnect switches. Switches shall be horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Auxiliary Contact Kit: NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 6. Service-Rated Switches: Labeled for use as service equipment.
 - 7. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac, unless noted otherwise.

2.2 SHUNT TRIP SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Cooper Bussmann, Inc.
 - 2. Ferraz Shawmut, Inc.
 - 3. Littelfuse, Inc.

- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight **green** ON pilot light.
 - 3. Isolated neutral lug;
 - 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 5. Form C alarm contacts that change state when switch is tripped.
 - 6. Three-pole, double-throw, fire-safety and alarm relay; suitable for 120-V ac or 24-V dc coil voltage.
 - 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D), or comparable product by one of the following:
 - 1. Eaton
 - 2. General Electric
 - 3. Siemens
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes larger than 100 A.
- D. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

END OF SECTION 26 28 16

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SECTION 26 28 17

ELEVATOR SAFETY SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide the labor, tools, equipment, and material necessary to install safety switches in accordance with the plans and as specified herein.

1.2 QUALITY ASSURANCE

- A. All work shall be performed in accordance with the latest edition of applicable standards, codes and laws.
 - 1. NFPA 70 – Current Edition; Article 620.
 - 2. ANSI/ASME A17.1 – Current Edition.
 - 3. BOCA 3006.2.3
 - 4. NFPA 72 – Current Edition.
- B. Except as modified by governing codes, all equipment shall be manufactured in accordance with the latest applicable standard
 - 1. U.L. 98 and CSA – C22.2 No. 4

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Elevator Control Switch in a single NEMA 1 enclosure with all necessary relay(s), control transformer and other options (as listed below), and as shown on drawings. The Elevator Control Switch shall be constructed, listed, and certified to the standards as listed in above. The Elevator Control Switch shall include the following features:
 - 1. Horsepower rated fusible switch with shunt trip capabilities. The ampere rating of the switch shall be based upon elevator manufacturer requirements and use Class J Fuses.
 - 2. Include as an accessory, a 100 VA control power transformer with primary and secondary fuses. The primary voltage rating shall match the incoming circuit voltage with a 120-volt secondary.
 - 3. Contain isolation relay (3PDT, 10 amp, 120V). The coil of the isolation relay shall be 120 Vac. A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid.
 - 4. Include a 120-volt key to test switch.
 - 5. Provide mechanically interlocked auxiliary contacts (1 N.O./1 N.C). rated 5A, 120 Vac as standard.

6. The switch shall contain the following options:
 - a. "ON" Pilot Light (Green)
 - b. Isolated Full Capacity Neutral Lug
 - c. Fire Alarm Voltage Monitoring Relay

B. Refer to Section "Fuses" for additional fuse requirements.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Where a specific manufacturer is listed in the drawings, this shall be considered the Basis-of-Design product.
1. Cooper Bussmann
 2. Eaton Corp.
 3. Littelfuse
 4. Mersen

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install safety switches as indicated, complying with manufacturer's written instructions.
- B. Install safety switches for use with elevator equipment, motors and controllers within sight of the motor position unless otherwise indicated.
- C. Provide suitable means for mounting safety switches.
- D. Use flexible conduit to and from safety switches where vibration isolation is required.
- E. Provide fuses sized in accordance with equipment manufacturer's data plate.
- F. Fuses shall not be installed until equipment is ready to be energized
- G. Touch-up all scratches after installation.

END OF SECTION 26 28 17

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual motor starters
 - 2. Full-voltage magnetic motor starters

1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D), or comparable product by one of the following:
 - 1. Eaton
 - 2. GE/ABB
 - 3. Siemens

2.2 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Configuration: Nonreversing.
 - 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
 - 3. Flush devices where installed in finished spaces, otherwise surface mounting.
 - 4. Red pilot light.
- C. Magnetic Controllers: Full voltage, across the line, electrically held.
 - 1. Configuration: Nonreversing.
 - 2. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 4. Control Circuits: **120V** ac.
 - 5. Integral CPT, with primary and secondary fuses, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - 6. Melting Alloy Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - 7. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
 - 8. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate **Class R** fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - 9. Nonfusible Disconnecting Means:

- a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
10. Auxiliary Devices: Provide heavy duty pushbuttons, LED pilot lights to indicate motor status, and Hand-Off-Auto (HOA) rotary switch. All devices shall be factory mounted in enclosure cover.

2.3 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Provide NEMA 1 enclosures for indoor dry environments. Where located outdoors, or in wet environments provide NEMA 3R enclosures, unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

3.2 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

- A. Bundle, train, and support wiring in enclosures.
- B. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Test continuity of each circuit.
 3. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages.
 4. Test each motor for proper phase rotation.
 5. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Enclosed controllers will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 29 13

SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes lightning protection system for the following:
 - 1. Ordinary structures.

1.2 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, coordinated with each other, using input from installers of the items involved:
- B. Qualification Data: For Installer.
- C. Product certificates.
- D. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Completion Certificate:
 - 1. UL Master Label Certificate

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: LPI Master Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. Dossert; AFL Telecommunications LLC.

3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. Newton Instrument Company.
9. O-Z/Gedney; A Brand of the EGS Electrical Group.
10. Robbins Lightning, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. UL Lightning Protection Standard: Comply with UL 96A requirements for **Class I (up to 75')** buildings.
- B. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

- A. Air Terminals:
 1. Copper or Aluminum unless otherwise indicated.
 2. Minimum 1/2-inch diameter by 12-inch long.
 3. Rounded safety tip.
 4. Threaded base support.
- B. Class 1 Main Conductors:
 1. Stranded Copper: 57,400 circular mils in diameter.
 2. Aluminum: 98,600 circular mils in diameter.
- C. Secondary Conductors:
 1. Stranded Copper: 26,240 circular mils in diameter.
 2. Aluminum: 41,400 circular mils in diameter.
- D. Ground Loop Conductor: Stranded copper.
- E. Ground Rods:
 1. Material: Copper-clad steel.
 2. Diameter: 3/4-inch.
 3. Rods shall be not less than 120-inches long.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.
- C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A.
- D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

- A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds listed for the purpose.
- B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. Perform inspections as required to obtain a UL Master Label for system.
 - 2. Perform inspections to obtain an LPI certification.
- B. Prepare test and inspection reports and certificates.

END OF SECTION 26 41 13

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SECTION 26 43 13

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes field-mounted Surge Protective Devices (SPDs) for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Refer to the following specification sections for Surge Protective Devices which are to be factory installed in equipment.
 - 1. 26 24 13 – Switchboards
 - 2. 26 24 16 – Panelboards

1.2 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **Five** years from date of Substantial Completion, unless listed otherwise in the following paragraphs.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Where surge protective device is shown attached to an automatic transfer switch or other equipment without integral overcurrent protective devices, provide surge protective device with integral disconnect switch.
- D. Provide device in powder coated, impact resistant steel enclosure. Where shown to be installed outdoors, provide weatherproof NEMA 3R enclosure.

2.2 SPD FOR SERVICE EQUIPMENT AND SWITCHBOARDS.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Joslyn by Thomas & Betts (JSP-240) or comparable product by one of the following:
 - 1. Eaton
 - 2. Emerson
 - 3. GE
 - 4. Schneider Electric
 - 5. Siemens
- B. Provide UL 1449, Type I devices suitable for the voltage shown on the drawings.

- C. Surge capacity of 240,000A per phase, 120,000A per mode, fully rated (SCCR) of 200KAIC, with TEN modes of protection (L-L, L-G, L-N, N-G). Each mode shall be protected with individually fused MOVs. Nominal discharge current (I-n) shall be 20,000A.

- 1. SPDs with the following features and accessories:
 - a. Indicator light display for protection status.
 - b. Surge counter.
 - c. Transient Filter complying with UL 1283 for electromagnetic interference.
 - d. Form-C contacts (1 N.O, 1 N.C.), for remote monitoring of protection status.

2.3 SPD FOR DISTRIBUTION EQUIPMENT

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Joslyn by Thomas & Betts (JSP-120) or comparable product by one of the following:

- 1. Eaton
- 2. Emerson
- 3. GE
- 4. Schneider Electric
- 5. Siemens

- B. Provide UL 1449, Type 2 devices suitable for the voltage shown on the drawings.

- C. Surge capacity of 120,000A per phase, 60,000A per mode, fully rated (SCCR) of 100KAIC, with TEN modes of protection (L-L, L-G, L-N, N-G). Each mode shall be protected with individually fused MOVs. Nominal discharge current (I-n) shall be 20,000A.

- 1. SPDs with the following features and accessories:
 - a. Indicator light display for protection status.
 - b. Surge counter.
 - c. Transient Filter complying with UL 1283 for electromagnetic interference.
 - d. Form-C contacts (1 N.O, 1 N.C.), for remote monitoring of protection status, where indicated on drawings.

2.4 SPD FOR PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Joslyn by Thomas & Betts (TransEnd 50) or comparable product by one of the following:

- 1. Eaton
- 2. Emerson
- 3. GE
- 4. Schneider Electric
- 5. Siemens

- B. Provide UL 1449, Type 2 devices suitable for the voltage shown on the drawings.

- C. Surge capacity of 100,000A per phase, 50,000A per mode, fully rated (SCCR) of 65KAIC, with TEN modes of protection (L-L, L-G, L-N, N-G). Each mode shall be protected with individually fused MOVs. Nominal discharge current (I-n) shall be 20,000A.
 - 1. SPDs with the following features and accessories:
 - a. Indicator light display for protection status.
 - b. Metallic flexible conduit whip.
 - c. Transient Filter complying with UL 1283 for electromagnetic interference.
 - d. Form-C contacts (1 N.O, 1 N.C.), for remote monitoring of protection status, where indicated on drawings.

2.5 SPD FOR SINGLE-PHASE LOADS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Joslyn by Thomas & Betts (Surgitron III) or comparable product by one of the following:
 - 1. Eaton
 - 2. Emerson
 - 3. GE
 - 4. Schneider Electric
 - 5. Siemens
- B. Provide UL 1449, Type 2 devices suitable for the voltage shown on the drawings.
- C. Surge capacity of 40,000A per phase, fully rated (SCCR) of 50 KAIC, with all modes of protection. Each mode shall be protected with individually fused MOVs.
 - 1. SPDs with the following features and accessories:
 - a. Indicator light display for protection status.
 - b. Metallic flexible conduit whip.
 - c. Three year warranty.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.

- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
 - 1. Final test and inspection reports shall document the quantity of surges recorded on all SPD surge counters at the completion of the testing, and the date that the observation was made.

3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 26 43 13

SECTION 265600

LIGHTING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide all labor, material, equipment, tools, and services necessary for, and incidental to, the proper installation of all interior and exterior luminaires herein specified and as shown on the Construction Documents. Provide all lamps for all fixtures of size and type as recommended by the fixture manufacturer and as scheduled.
- B. Types of fixtures, reflectors, refractors, lenses, louvers, ballasts, and lamps shall be as shown on the Construction Documents in the Luminaire Schedule, and shall be furnished complete with plaster frames, bar hangers, mounting stems, and other accessories necessary for proper installation.

1.2 QUALITY ASSURANCE

- A. All luminaires shall conform to the requirements of the National Electrical Code (NEC), NEMA, ANSI, IEEE, IES, CBM, NFPA, and shall be labeled with the Underwriters Laboratories Seal of Inspection.
- B. Luminaires shall comply with all requirements of the Regulatory Agencies and shall conform to State Code, Local Codes, and Ordinances.
- C. Integrated equipment rating tests shall be factory performed and adjusted for rated continuous current, rated light output, enclosure stability, and dielectric strength.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be stored to protect them from damage prior to installation. Material shall not be stored directly on the ground or floor and shall be kept as clean and dry and free from damage or deteriorating elements.
- B. Deliver products to project properly identified with names, types, grades, compliance labels and similar information needed for distinct identification. Materials must be adequately packaged or protected to prevent deterioration during shipment, storage and handling.
- C. The finished surfaces of all luminaires shall not be defaced in any way and shall be cleaned to original finish at time of completion of the work.

1.4 SUBMITTALS

- A. Submittal Schedule
 - 1. Within thirty (30) days of contract award, the Contractor shall submit a complete list of lighting products he intends on furnishing with manufacturer and catalog designations,

along with currently quoted lead times for delivery of same. Should the Contractor anticipate that the delivery schedule of any specified product may adversely impact the construction schedule, he shall bring it to the attention of the Architect or Owner's Representative at this time.

2. Within thirty (30) days of bid award, contractor shall provide a complete list of all lamps which will be furnished on the project. This list shall be organized alphabetically by the luminaire type indicated on the luminaire schedule, and include the manufacturer and exact model number of each lamp.
 3. Luminaires shall not be lot priced, provide unit pricing.
- B. Shop Drawings: Indicate dimensions and components for each luminaire, not standard product of manufacturer. Provide shop drawings for each type of lamp, ballast and driver specified. Submit cover sheet with a matrix of all luminaire types and catalog numbers submitted.
- C. Product Data:
1. Submit physical characteristics of each luminaire showing conduit entrances, physical dimensions, component locations, electrical ratings, mounting hardware, and nameplate nomenclature.
 2. Submit manufacturer's written recommendations for storage and protection, installation and instructions, and field test requirements.
 3. Submit certified reports of fixture performance in accordance with IESNA accepted standards in IES photometric format covering candlepower distribution curves, luminaire efficiency, coefficients of utilization, and isolux chart (both horizontal and vertical footcandles) for each luminaire.
 4. Submit manufacturer's instructions for testing, troubleshooting, performing cleaning, and operating and maintenance.
- D. Substitutions
1. The lighting equipment specified herein has been carefully specified for its ability to meet the luminous environment requirements of this project. Calculations have been performed by the design team to determine horizontal and vertical illuminances. Equipment and manufacturers which have been shown to comply with established criteria are specified. Substitutions in all likelihood will be unable to meet all of the same criteria as the specified equipment.
 2. Voluntary product substitutions from the Contractor will not be considered without prior approval to submit from the Lighting Designer.
 3. Should the Contractor wish to have products considered other than those specified, they must submit those items ten (10) days in advance of the bid. Non-returnable working samples of the unsolicited substitutions should be included. Failure to submit within that deadline will require that the specified products will be supplied. Submittal of a bid for this project shall include a written acknowledgment of these terms from the Contractor.
 4. Bid value shall not be based on substitutions in expectation of approval.

1.5 CLOSEOUT SUBMITTALS

- A. Submit an itemized list, including Manufacturer's order numbers, of each type of lamp, light source and power supply to be able to obtain identical replacement lamps.

PART 2 - PRODUCTS

2.1 LUMINAIRES

- A. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.
- B. Provide all sources of a particular type or classification by the same manufacturer to maintain color consistency throughout the project.
- C. All LED luminaire manufacturers shall provide electrical and photometric data performed in accordance with IESNA LM-79-08 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
- D. LED luminaires shall be designed with heat sinking adequate such that the junction temperature of the LEDs is maintained to meet the rated life as published by the LED manufacturer. Luminaire manufacturer shall provide validation documentation.
- E. Manufacturer shall provide photometric performance data on luminaires in accordance with ANSI/IES LM-63-02: ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.
- F. LED luminaires shall have a minimum complete five year warranty from the date of installation unless a ten year warranty is required per the luminaire schedule.

2.2 LUMINAIRE MANUFACTURERS

- A. Manufacturers
 - 1. The Base Bid lighting fixtures shall be from the Manufacturers listed in the Luminaire Schedule on the Drawings. Contractor shall only submit on the products that are specified, or those listed as alternates. Submission of unsolicited substitutions will be treated as Non-Listed Manufacturers.
 - 2. Manufacturers not listed must be pre-qualified to bid as follows:
 - a. Manufacturer shall have not less than five years experience in design and manufacture of lighting fixtures of the type and quality shown. Pre-qualification submissions must include a list of completed projects and dated catalog pages indicating length of experience.
 - b. Manufacturer shall also submit a working 120Volt non-returnable sample with cord and plug for review by the Owner's Representative and Lighting Designer.
 - 3. Single source luminaires are listed based solely on specific performance criteria to that luminaire and require unit pricing on bid day. Single source luminaire shall not be lot priced.
- B. Construction
 - 1. Fixture enclosures shall be fabricated with a minimum of 20 gauge cold rolled steel. Enclosures may be of other materials, provided they are equal in mechanical strength.
 - 2. Recessed downlight reflectors required to have "haze" Alzak finish and be constructed of one-piece of spun aluminum unless otherwise specified in the Luminaire Schedule. All ceiling trims must fit tight to the luminaire with no light leaks.
 - 3. No labels or stickers are to be visible through the luminaire.
 - 4. Adjustable accent luminaires must have locking tilt and locking rotation to ensure focus is not disturbed during re-lamping and maintenance.

2.3 LED LIGHT SOURCES

- A. All LED light sources intended for indoor application shall have a correlated color temperature of 4000K per Owner Direction (unless specifically noted in the schedule).

- B. Published LED life ratings shall be based on the point at which LED sources reach L70 lumen maintenance and tested in accordance with IES LM80-08 Approved Method: Testing Lumen Maintenance of LED light sources.
- C. In instances where the LED sources are to be mounted directly into the architecture, the LED manufacturer shall provide a recommended heat sink volume adequate to achieve rated life at L70.
- D. All LEDs light sources shall have a CRI ≥ 80 .
- E. All LED sources shall have $\leq$ to 3 step binning for color consistency and uniformity.

2.4 LED DRIVERS

- A. General Requirements:
 - 1. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment.
 - 2. Operate for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.
 - 3. Provide thermal fold-back protection by automatically reducing power output (dimming) to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions that approach or exceed the LED driver's maximum operating temperature at calibration point.
 - 4. Provide integral recording of operating hours and maximum operating temperature to aid in troubleshooting and warranty claims.
 - 5. Designed and tested to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
 - 6. Manufactured in a facility that employs ESD reduction practices in compliance with ANSI/ESD S20.20.
 - 7. UL 8750 recognized or listed as applicable.
 - 8. UL Type TL rated or UL Class P listed where possible to allow for easier fixture evaluation and listing of different driver series.
 - 9. Suitable for field replacement as applicable; listed in accordance with UL 1598C or UL 8750, Class P as indicated.
 - 10. Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.
 - 11. Class A sound rating; Inaudible in a 27 dBA ambient.
 - 12. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.
 - 13. LED drivers of the same family/series to track evenly across multiple fixtures at all light levels.
 - 14. Offer programmable output currents in 10 mA increments within designed driver operating ranges for custom fixture length and lumen output configurations, while meeting a low-end dimming range of 100 to 1 percent or 100 to 5 percent as applicable.
 - 15. Meet NEMA 410 inrush requirements for mitigating inrush currents with solid state lighting sources.
 - 16. Employ integral fault protection up to 277 V to prevent LED driver damage or failure in the event of incorrect application of line-voltage to communication link inputs.
 - 17. LED driver may be remote located up to 100 feet (30 m) from LED light engine depending on power outputs required and wire gauge utilized by installer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fixtures, lamps, lenses, etc., after building is enclosed, weathertight, and environmental conditions are nominally the same as expected for the complete spaces. All lamps, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches. Glassware and lamps shall not be installed until approved by the Owner's Representative. Every luminaire shall have a lighting outlet unless otherwise directed. In instances where a specific type of fixture has not been assigned to an outlet, provide a complete fixture of the type and wattage designated for outlets of similar function and/or type as directed by the Owner's Representative or Engineer.
- B. Furnish and install all necessary hangers, supports, framing, fittings, etc., to support fixtures and fixture outlets. All fixture supports shall be securely anchored to the ceiling and/or building construction and shall be capable of supporting the fixture in question plus 100% additional weight. Recessed 2' x 4' and 2' x 2' fluorescent fixtures shall be independently wire supported at each corner of the fixture from the structural ceiling (not the ceiling grid). This Contractor shall coordinate with the Ceiling Contractor to insure that these supports are installed. Fluorescent fixtures utilizing single ended compact fluorescent lamps shall be installed so all fixtures within a room or area are oriented in the same direction.
- C. For recessed (flush) mounted fixtures, the Contractor shall coordinate the installation and construction details with ceiling system in which they are installed, i.e. support system dimensions, flanges (where required), acoustical tile, or pan pattern, etc. The Contractor shall verify the specific ceiling construction is appropriate for the fixture specified before ordering the luminaires. This Contractor shall coordinate his work with that of structural, masonry, patching, plastering and acoustical tile Contractors to assure proper locations of openings for all fixtures. Ceiling outlets in acoustical tile ceilings shall be spaced and installed so as to replace the ceiling tile in accordance with the acoustical ceiling layouts.
- D. Flush type fluorescent and incandescent fixtures shall be securely fastened to the ceiling framework, and supplied with finished metal trim for plastered or acoustical ceiling. In general, the Manufacturer and catalog number of the fixture type is given in the Luminaire Schedule; however, this Contractor shall verify the ceiling suspension system to be installed and shall provide the proper type fixture suspension straps, retaining clips, supporting hooks, etc., as required to properly support the fixture. Flange type, snap-in or lay-in fixture trims shall be furnished, as required, for the ceiling system installed.
- E. All suspended fixtures shall be constructed with swivel device such that canopies will neatly fit slope of ceilings and fixtures hang plumb. Flexible conduit or cord connections will not be approved for feeding suspended fixtures, unless specifically indicated in the Luminaire Schedule.
- F. Flush fixtures shall have the branch circuit system terminated in a junction box above the ceiling, but accessible through ceiling opening. Four feet (4') of 1/2" flexible metal conduit shall be provided between the junction box and the fixture housing.
- G. All exposed fixture housings shall be so installed that the housing surface, trim frame, door frame, and lens frame shall be free of light leaks. The lens door shall close in a light-tight manner.
- H. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, and latches shall function easily by finger action without the use of tools.

- I. Only the number of lamps required to provide adequate temporary lighting for construction work to be completed shall be installed by this Contractor at the time luminaires are installed and tested. The remaining lamps shall be installed within 30 days of final inspection of the project. All lamps shall be in working order at the time of final acceptance of the work by the Owner's Representative and the Owner. This Contractor shall replace all defective lamps with new lamps until the work is finally accepted. All lamps shall be guaranteed for their published rated operating life.
- J. Recessed incandescent luminaires for installation in ceiling construction, where fixtures will be in direct contact with thermal insulation, shall be equipped with internal thermal protection and shall be so identified. Recessed incandescent luminaires installed flush in suspended grid ceilings, where fixtures will not be in direct contact with thermal insulation, shall be standard fixture so identified for this particular type of installation.
- K. Exterior wall mounted fixtures shall have the joint between the fixture and wall on top and both sides sealed with a silicon sealer. Do not seal the joint at the bottom to allow for drainage.
- L. Upon completion of installation of interior luminaires, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
- M. At date of substantial completion, replace lamps in interior luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Owner's Representative/Engineer. Furnish stock of replacement lamps amounting to 5 percent (but not less than one lamp in each case) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner's storage space.

3.2 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTABLE LUMINAIRES

- A. Aim and adjust luminaires as directed by the Lighting Designer, Owner's Representative, or Electrical Engineer.

3.4 CLEANING

- A. Fixtures shall be mounted straight, level and true to the building lines. Warped or damaged fixtures shall be replaced or repaired to the satisfaction of the Owner's Representative and Owner.
- B. Immediately preceding the final inspection, this Contractor shall thoroughly clean all fixtures of dust, dirt, grease, fingermarks, etc. All lamps shall be operating at the time of Owner's acceptance.

3.5 PROTECTION OF FINISHED WORK

- A. Relamp luminaires having failed lamps at Substantial Completion.

END OF SECTION 265600

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SECTION 26 56 19

LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for LED luminaires indicated in the Luminaire Schedule on the drawings.
- B. Luminaire supports.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests IES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - 7. LED driver or power supply product data sheets for each luminaire.

- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Where specifically indicated on plans, include photometric PxP drawings for areas where alternate fixtures are supplied.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Certificates: For each type of luminaire.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. One (1) copy of each approved submittal.
 - 2. Certificate of Material Receipt.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Drivers: TEN percent of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: ONE percent of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: ONE percent of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.
- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- C. Mockups: For exterior luminaires, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: FIVE year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Refer to Luminaire Schedule on drawings for Luminaire types and construction requirements.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- E. UL Compliance: Comply with UL 1598 and listed for wet location.
- F. LED lamps and driver shall have a rated life of minimum 50,000 hours.
- G. LED driver shall meet ANSI C62.41 Category. A surge protection standard up to 4 kV.
- H. CRI of minimum 80. CCT of 4000K unless otherwise noted.
- I. Ambient Temperature: LED Luminaire shall be rated from 5 deg F to +104 deg F.
- J. In-line Fusing: Separate in-line fuse for each luminaire.
- K. LED Lamp Module Rating: Lamp marked for outdoor use.
- L. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- M. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE TYPES

- A. Provide types as indicated in Luminaire Schedule and as indicated on drawings.

2.3 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Metal Components: As indicated in Luminaire Schedule. Form and support to prevent warping and sagging.
- C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.4 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Finish Color: Unless otherwise noted, color shall be selected by the architect. Provide color chip samples or selection sheet with shop drawings.

2.5 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Fasten luminaire to structural support.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Where recommended by luminaire manufacturer, attach to structural members in walls. Otherwise mount fixture to back box.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Coordinate layout and installation of luminaires with other construction.

H. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Refer to details on drawings for mounting orientation and requirements.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.

- b. IES LM-50.
- c. IES LM-52.
- d. IES LM-64.
- e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

END OF SECTION 265619

SECTION 27 00 01

GENERAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Acceptance Testing Authorities (ATA) - The individuals and/or business entities that participate in Acceptance Testing and report to the Owner when work appears to be complete. These parties represent the interest of the Owner.
- B. Authority Having Jurisdiction (AHJ) - The governmental agency or sub-agency having authority over the construction process and having the ultimate authority to enforce, uphold and rule on codes and safety compliance at the project site.
- C. Contractor – The entity(s) contractually responsible for performing work of this Division.
- D. Wherever the words “Site”, “Project Site”, or “Premises” appears in these specifications or related drawings, it shall be interpreted to mean all real estate, buildings and structures where work will be performed and where products will be installed and reside.
- E. Commissioning Authority – An agent of the Owner, often independent of the design team, responsible for ensuring compliance with the Owner’s project intent.
- F. Contractor of Record – The Contractor entering into a contract for all or part of the work of this division directly with the Owner, directly with the Construction Manager or directly with a General Contractor.
- G. Designer – The Consultant(s) representing the Owner and directly responsible for specification of work within this Division including their related drawings. The Designer may or may not be affiliated with the architectural or an engineering firm of record for this Project. The Designer is a member of the project Design Team.
- H. Furnish – To supply product or labor (context dependant) including all associated shipping, storage, travel, lodging, miscellaneous and warranty expenses.
- I. High Voltage – For the sake of this division, greater than 70.7VAC RMS; greater than or equal to 100VAC P-P; greater than 70.7VDC
- J. Install – To supply all labor, tools and incidental materials necessary to handle, store, mount, terminate, program, configure and adjust a product in order to fulfill the requirements of this project.
- K. Low Voltage – For the sake of this division, less than or equal to 70.7VAC RMS; less than 100VAC P-P; less than or equal to 70.7VDC

- L. Medium Voltage – For the sake of this division, greater than 70.7VAC RMS; greater than or equal to 100VAC P-P; greater than 70.7VDC.
- M. Nominal Operating Level: The standard signal voltage/power reference which a manufacturer has designed its product's inputs and outputs to operate at in order to achieve specified performance.
- N. Provide – To furnish and install, inclusive of accessories, modules, and ancillary items necessary to render the respective product and system fully operational and usable to the Owner for its intended purpose.
- O. Substantial Completion
 - 1. The point in this project where all work of this Division that occurs at the project site has been completed. For work to be substantially complete, all of the following must be valid:
 - a. All products have been delivered and installed at the project site, and;
 - b. All portable and loose equipment has been delivered, and;
 - c. All systems have been installed, adjusted and are usable by the owner for their intended purpose, and;
 - d. All products, including cables, have been labeled in accordance with these specifications and related drawings, and;
 - e. All systems are performing in accordance the design intent of these specifications, drawings and reference standards, and;
 - f. All systems have been demonstrated as complete and working to the
 - g. Designer, and;
 - h. All systems have been demonstrated as complete and working to Owner, and;
 - i. The Contractor has successfully completed Acceptance Testing of all work of all sections.
 - j. The Contractor has complied with all additional requirements of the
 - k. Contract.
- P. Work – The supply of products, materials, labor, incidentals and services necessary to fulfill the complete requirements of this project.
- Q. Acronyms and Abbreviations
 - 1. ADA - Americans with Disabilities Act
 - 2. AM – Amplitude Modulation
 - 3. ANSI – American National Standards Institute
 - 4. ASME - American Society of Mechanical Engineers
 - 5. ASTM – American Society of Testing Materials
 - 6. ATM – Asynchronous Transfer Mode
 - 7. AWG – American Wire Gauge
 - 8. BGP – Border (Boundary) Gateway Protocol
 - 9. BICSI - Building Industry Consulting Services International
 - 10. BIT – Binary digit
 - 11. BOM – Bill of Material
 - 12. Bps – Bits per second
 - 13. BRI – Basic Rate Interface
 - 14. CAD – Computer Aided Design
 - 15. CAN – Campus Area Network

16. CATV – Community Antenna Television
17. CCITT – Consultative Committee for International Telegraphy and Telephony
18. CCTV – Closed Circuit Television
19. CDDI – Copper Distributed Data Interface
20. CLEC – Competitive Local Exchange Carrier
21. CPE – Customer Premises Equipment
22. CPU – Central Processing Unit
23. CSA – Canadian Standards Associations
24. CSMA/CA – Carrier-Sense Multiple Access with Collision Avoidance
25. CSMA/CD – Carrier-Sense Multiple Access/Collision Detection
26. CSU – Channel Service Unit
27. db - Decibel
28. Device ID – A system specific label assigned to a product to uniquely identify it within a given a system.
29. DSL – Digital Subscriber Line
30. DSU – Data Service Unit/Digital Service Unit
31. DTE – Data Terminal Equipment
32. EF – Entrance Facility
33. EGP – Exterior Gateway Protocol
34. EIA – Electronics Industries Association
35. EMI – Electromagnetic Interface
36. ER – Equipment Room
37. ETSI – European Telecommunications Standards Institute
38. FCC – Federal Communications Commission
39. FDDI – Fiber Data Distributed Interface
40. GAN – Global Area Network
41. GB – Giga Byte
42. Gb/s (Gbps) – Gigabits per second
43. GHz – Gigahertz
44. IDF – Intermediate Distribution Frame (Replaced by TR)
45. IEEE – Institute of Electrical and Electronics Engineers
46. IP – Internet Protocol
47. IPX – Internet Packet Exchange
48. ISDN – Integrated Services Digital Network
49. ISO – International Organization for Standardization
50. ISP – Internet Service Provider
51. LAN – Local Area Network
52. LANE – LAN Emulation
53. LASER – Light Amplification by Stimulated Emission of Radiation
54. LAT – Local Area Transport
55. LATA – Local Access and Transport Area
56. LEC – Local Exchange Carrier
57. LED – Light Emitting Diode
58. MAC – Media Access Control
59. MAN – Metropolitan Area Network
60. MB – Mega Bytes
61. Mb/s (Mbps) – Megabits per second
62. MDF – Main Distribution Frame (Replace by ER)
63. MHz – Megahertz
64. MODEM – Modulator/Demodulator
65. ms – millisecond

- 66. MTBF – Mean Time Between Failures
- 67. MPLS – Multi Protocol Label Switching
- 68. OC – Optical Carrier
- 69. OFCI – Owner Furnished Contractor Installed
- 70. OFE – Owner Furnished Equipment
- 71. OFOI – Owner Furnished Owner Installed
- 72. OSI – Open Systems Interconnection
- 73. PAN – Personal Area Network
- 74. pps – Packets Per Second
- 75. PRI – Primary Rate Interface
- 76. PSTN – Public Switched Telephone Network
- 77. QoS – Quality of Service
- 78. RAID – Random Array of Inexpensive Disks
- 79. RAM – Random Access Memory
- 80. RBOC – Regional Bell Operating Company
- 81. RF – Radio Frequency
- 82. RFC – Request For Comment
- 83. RFI – Request For Information/ Radio Frequency Interference
- 84. RFP – Request For Proposal
- 85. RFQ – Request For Quotation
- 86. RIP – Routing Information Protocol
- 87. RMON – Remote Monitor
- 88. ROM – Read Only Memory
- 89. SMTP – Simple Mail Transfer Protocol
- 90. SNA – Systems Network Architecture
- 91. SNMP – Simple Network Management Protocol
- 92. SONET – Synchronous Optical Network
- 93. TB – Tera Byte
- 94. TCP – Transmission Control Protocol
- 95. TCP/IP – Transmission Control Protocol/Internet Protocol
- 96. TIA – Telecommunications Industries Association
- 97. TR – Telecommunications Room
- 98. VoIP – Voice over Internet Protocol
- 99. WAN – Wide Area Network

1.2 QUALITY ASSURANCE

- A. The Contractor shall have a business history of at least (5) years performing Work of similar type as that specified in these project documents. In addition, the Contractor shall also be able to demonstrate through valid references and other Designer required support information that it has successfully completed no less than (6) projects of similar or greater contract value, with like system types, and including similar scope of work within the last 24 calendar months. This applies to each section of work individually.
- B. Contractor shall be a “factory-authorized” reseller (distributor, dealer, integration partner and/or channel partner) for at least 70% of the product value to be supplied.
- C. Contractor shall have substantial business operations located within a (300)-mile radius of the project site with full-time employee staff actively engaged in the supply,

installation and service of systems and equipment of the type and scope herein specified.

- D. Contractor shall have full-time employee service staff based within a (50)-mile radius of the project site.
- E. Contractor shall supply any additional information requested by the Designer deemed appropriate by the Designer to validate the Contractor's qualifications and its ability to perform and warranty the specified work within the time frame allotted and of the quality expected.
- F. Contractor shall provide the services of locally licensed and authorized electrician(s) to perform that portion of the work of this division that is required by the applicable codes and/or the AHJ to be performed by licensed electrician(s).
- G. Superintendent/Project Manager
 - 1. The Contractor shall furnish the services of an experienced superintendent/Project Manager who shall be constantly in charge of the work, together with a qualified Foreman and technical specialists to properly install, connect, adjust, start, operate and test the work involved.
 - 2. The superintendent's/Project Manager's qualifications shall be subject to the review and acceptance by the Designer and Owner. Unless the Designer and Owner grants prior special permission, the same Superintendent/Project Manager shall be utilized throughout the duration of the project and shall remain responsible for the complete scope of the Contract.
- H. Subcontractors
 - 1. If the Contractor, as a singular entity, does not meet 100% of the quality assurance requirements for all specification sections, the Contractor shall enlist the services of qualified subcontractors to perform the work of those section(s) for which Contractor is not fully qualified. This includes but is not limited to the supply of the products for the section but also the supply of the project engineering services, preparation of shop drawings and section submittals, technical installation labor, training, warranty, post installation support and service.
 - 2. The Contractor shall ensure that each Subcontractor supplies the services of a project manager to represent the interest of the Subcontractor at all project meetings in which the Contractor is also required to participate. This requirement is mandatory as an aid towards ensuring that the special needs and timing of subcontracted work are fully represented to the project team.
 - 3. The Designer and Owner reserve the right to disqualify the use of any subcontractor that does not meet the quality assurance requirements set forth in these specifications. Should a subcontractor be disqualified, the Contractor shall supply the services of a different subcontractor that complies with the published quality assurance requirements. The Contractor is solely responsible for costs incurred as a result. It is therefore incumbent upon the Contractor to pre-qualify subcontractor choice(s) prior to submitting pricing for work.
 - 4. For the purposes of achieving quality assurance compliance, an equipment vendor that is not performing the technical installation labor associated with work of a section shall not be considered a subcontractor

I. Trainer Qualifications

1. Individual(s) conducting training shall be fully knowledgeable of the product, system and technology on which they will be training. These individuals shall be factory trained, factory certified and/or otherwise approved by the Designer as having sufficient experience and knowledge in the area of interest to conduct training.

1.3 SUBMITTALS

- A. Refer to Section 26 00 15 "Submittals".

1.4 WARRANTY

- A. Unless otherwise noted, all materials and workmanship furnished shall be covered by the Contractor for a minimum period of (1) year from date of Acceptance Testing Completion or Substantial Completion (whichever is later) for related work.
1. Supplied products with manufacturer's warranties of less than the warranty term shall be extended by the Contractor for the full specified warranty term.
 2. Supplied products featuring a standard manufacturer's warranty whose term extends beyond the Contract Warranty term shall be shall be facilitated by the Contractor for the full duration and conditions of the manufacturer's warranty.
- B. The Warranty supplied shall be a full "System Warranty" that covers all supplied products, onsite and off-site labor and related personnel transportation and product shipping expenses.
1. During this period the Contractor will remedy (at no cost to the Owner) any problem with the system, or any of its related components that is the result of defective materials, equipment settings, workmanship, or loss of programming.
- C. Individual sections of this Division may feature more stringent requirements than those set forth in this section. The most stringent of these requirements shall apply.
- D. All warranty work shall be performed at the Contractor's expense and to the satisfaction of the Owner and Designer.
- E. Response Requirements
1. During the Warranty Period, the Contractor shall:
 - a. Respond by phone within four (4) business hours of notice by the Owner of a problem, and;
 - b. Supply qualified personnel onsite within (1) business day or (72) contiguous hours (which ever comes first) to begin remediation of the problem, if the problem cannot be remediated over the phone in less time, and;
 - c. Supply "on-call" emergency response service labor (at the request and authorization of the Owner) at a hourly rate that does not exceed the Contractor's published emergency service rates, nor two-times the Contractor's standard hourly rate, whichever is lower.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials, apparatus and equipment shall bear the Underwriter's Laboratory, Inc. label (or other nationally recognized testing laboratory label) where regularly supplied, and as additionally required by Code.
- B. All products furnished shall be new, full weight and of the best quality. All similar materials shall be of the same type and from the same manufacturer.
- C. In the event that a specified product is discontinued by the manufacturer and is no longer available for purchase, the Contractor shall provide replacement product of equal or greater value, performance and function as that of the Basis of Design product. The replacement product shall be from the same manufacturer as that of the Basis of Design equipment unless written permission has been granted by the Designer. The Contractor is solely responsible for researching and submitting proposed replacement product. The final decision as to whether a Contractor proposed replacement is acceptable lies solely with the Designer
- D. Substitute products will only be considered provided that the Contractor has strictly adhered to the guidelines set forth by Division 1 Specifications.

PART 3 - EXECUTION

3.1 WORK AND WORKMANSHIP

- A. Provide all required labor, materials, equipment and Contractor's services necessary for complete installation of systems required to comply with the requirements of authorities having jurisdiction, as indicated on Drawings, and as specified.
- B. Work shall be functional and complete in every detail, including any and all items required to complete the system, regardless of whether all items have been fully enumerated or shown on the Drawings.
- C. Special attention shall be given to access to working and controlling parts. Adjustable parts shall be within easy reach. Removable parts shall have space for removal.
- D. Contractor and Subcontractors shall be fully knowledgeable of the details of all Work to be performed by other trades and shall take necessary steps to integrate and coordinate Work of This Division with that of other Divisions and other trades.
- E. Wherever tables or schedules show quantities, they shall not be interpreted to represent the total contract quantity requirement, but instead a portion of the contract requirement. The Contractor shall be responsible for the higher quantity communicated by the drawings, within the specifications and on the schedules/tables. Seek clarification from the Designer should a discrepancy between them be found.

- F. The Designer and Owner's Representative have the full power to condemn or reject any Work, materials or equipment not in accordance with these Specifications and Construction Drawings or the manufacturer's specifications or drawings reviewed by the Designer or Owner.
- G. Work or equipment that is rejected shall be removed and replaced to the satisfaction of the Owner at the Contractor's expense. Work or equipment that is rejected shall be so stated in writing by the Owner or Designer.
- H. Such decisions that the Owner or Designer may make with respect to questions concerning the quality, fitness of materials, equipment, and workmanship shall be binding upon the parties thereto.
- I. Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation guidelines.
- J. All Work shall be performed with the best practices of the trade for performance, functionality, safety, endurance, and aesthetics.
- K. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.
- L. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible. Consult the Designer for direction.
- M. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
- N. Supply scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
- O. Equipment shall not be hidden or covered up prior to inspection by the Owner's representative. Work that is determined unsatisfactory shall be corrected immediately.
- P. Work shall be installed level and plumb, parallel and perpendicular to prevailing building lines, except as expressly detailed otherwise or required for proper form, function or Designer intended operation.
- Q. Install equipment and materials in strict accordance with the manufacturer's written instructions. Bring conflicts between the manufacturer's written instructions and these project documents to the attention of the Designer for review and direction.
- R. Upon completion of installation of equipment and communication circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with re-testing.

3.2 TESTING

A. General

1. Upon complete physical installation of products, the Contractor shall align, balance, and adjust equipment to make it usable to the Owner for its intended purpose, and to ensure compliance with all related drawings, specifications and references.
2. The Contractor shall fully test each system, and each component thereof, and correct all deficiencies prior to scheduling acceptance testing.
3. Replace malfunctioning or damaged products with new product, following immediately with retesting until satisfactory performance and specification compliant conditions are achieved.

B. Operational Testing

1. Perform operational testing of all supplied products, individually and collectively, to verify conformance with these project documents, and as required ensuring compliance with the product manufacturer's published specifications and as additionally necessary for the system to meet the intended purpose.
2. Perform operational testing of Owner furnished equipment to the extent necessary to verify overall system functionality and specification compliance. Report any compliance problems that are directly the result of Owner Furnished Equipment.
3. Although each system requires additional supplemental testing to confirm compliance, the following testing shall be conducted as they apply to the supplied systems products.
 - a. Verify all functions of all supplied equipment as applicable to the design, functionality and intended use of the system.
 - b. Test each system inputs and output.
 - c. Test each remote control.
 - d. Test each source device
 - e. Setup and test portable equipment.

C. Performance Testing

1. Perform all measurements and testing necessary to demonstrate performance compliance.

3.3 ACCEPTANCE TESTING

A. Acceptance Testing is conducted by the Designer and/or the Owner's designated Commissioning Authority and/or the Owner.

B. Acceptance testing occurs following the submittal and review of required Pre-Acceptance Submittal(s).

C. Acceptance testing may include, but may not necessarily be limited to:

1. Visual and mechanical inspections of Contractor's workmanship
2. Inventory of equipment
3. Random system and/or component measurements to verify compliance with specifications and to check of the accuracy of the Pre-Acceptance Submittal and as-built drawings
4. Inspection of system components, sub-systems, software, component functionality, etc...

5. Other tests and/or inspections as determined necessary by the Designer
 6. Functional tests of system
 7. Performance measurements of components or groups of components
- D. The Contractor shall be onsite in advance of the scheduled acceptance testing time to get prepared for and stage for testing. Contractor shall schedule and coordinate acceptance testing with all parties. Contractor shall coordinate and ensuring free access into all areas of work.
- E. The Contractor shall have qualified technical representation onsite to work with the Designer during Acceptance Testing. The representative(s) shall be fully familiar with aspects of the work being evaluated.
- F. Prior to the start of Acceptance Testing the Contractor shall have turned over a copy of the most up-to-date as-built documentation.
- G. The Contractor shall furnish and shall have present at the project site test equipment, cables, tools and personnel necessary to test, verify and demonstrate any product, operation, and workmanship deemed necessary by the Designer.
- H. The Contractor shall be prepared to demonstrate the presence of supplied products, cabling and installation methods. The Contractor shall be prepared to demonstrate the operation of all systems (and each requested component thereof) and shall be prepared to make electronic, physical or software related adjustments to the system or any of its components to the satisfaction of the Designer.
- I. Corrective actions may not be undertaken by the Contractor during Acceptance Testing that in any way impedes Acceptance Testing progress or negatively alters the day's schedule.
- J. Acceptance Testing shall not pass if any of the following conditions are true.
1. Inspections do not substantially match the Pre-Acceptance Submittal.
 2. Inspections do not match the criterion of these specifications.
 3. The Contractor's workmanship does not appear to be of professional quality.
 4. The Contractor has failed to follow established installation requirements.
 5. As-built drawings have not been presented to the Designer prior to the commencement of Acceptance Testing.
 6. As-built drawings are found to be incomplete or inaccurate.
 7. More than one cable is found to be missing a required label.
 8. More than one cable is found to be inaccurately recorded on the as-built drawings.
 9. Installed equipment does not match the equipment specified and/or previously authorized for use by the Designer.
 10. More than one unit of equipment, cable, connector, circuit, etc... fails to pass a test performed on it.
 11. There are substantive workmanship issues judged by the Designer to be negative and are of material importance to the long-term usability, safety, professional appearance, or service and maintainability of the Contractor's work.
 12. There is any material deviation from the intent of these specifications.

- K. Contractor is entitled to no more than (2) acceptance testing visits per system. One primary visit and one follow-up (secondary) visit. The Contractor is responsible for reimbursement of Designer fees associated with each additional visit that is the result of the Contractor's failure to be complete; the Contractor's failure to comply with the requirements of the contract documents; or the Contractor's failure to be fully prepared for acceptance testing at the date and time scheduled. The cost for subsequent acceptance testing visits shall be \$1500 per person, per day, plus travel and other expenses.
 - 1. An Acceptance Testing report (i.e. punch list) will be supplied by the Designer following each official Acceptance Testing visit enumerating issues found during the visit.
- L. Should the Designer conclude that the Contractor has inaccurately represented the level of completion, the Designer reserves the right to abort the balance of the days' scheduled acceptance testing and the Contractor shall be docked one acceptance testing visit for each system not evaluated.

3.4 TRAINING

- A. Training shall be supplied for each section of this Division and for each unique system provided.
- B. The Owner shall have the right to use total allocated training for a period of (365) calendar days following final completion of onsite work, solely at its discretion.
- C. Training shall be supplied as expressly identified within individual sections. Where training requirements are not otherwise expressly identified, the Contractor shall supply a minimum of (2) hours per unique system, per section. The Contractor shall presume that at least (2) discrete trips to the project site shall be required per unique system to conduct training.
- D. Training dates and times shall be coordinated with the Owner's designated training representative(s).
- E. Training shall cover the following:
 - 1. Normal system use and operation
 - 2. Procedures and schedules involved in troubleshooting and performing routine preventative maintenance.
 - 3. Other facets as identified in individual sections
- F. Agenda and relevant training handouts shall be prepared and distributed to attendees at each training session.
- G. A sign-in sheet shall be created and used for each training session. The sheet shall:
 - 1. The section and system(s) being trained upon.
 - 2. The date and starting time of the session.
 - 3. The signatures of all attendees.
 - 4. The ending time of the session, along with a separate owner signature certifying the ending time.
 - 5. Have attached to it a copy of the training outline/agenda.

H. Recording of Sessions

1. When a related section requires recording of supplied training sessions they shall be recorded.
2. Recordings shall be supplied on DVD video format media playable in standard consumer grade reproduction appliance. Recordings do not need to be professionally edited but shall feature intelligible audio and a clear image of the subject trainer and any supplemental visual content material to the training.
3. Recordings shall be turned over and signed for by an Owner's training representative at the end of each session. A copy of a signed delivery receipt shall be included as part of the Contractor record documentation.
4. Contractor shall require each attendee to sign-in at the start of each training session. The sign-in form shall summarize the training conducted, specification section and system being trained on, as well as the starting time and duration of training. Following training, a representative of the Owner shall sign the form, acknowledging the same. Contractor shall retain the original copy of these forms and turn over a photo copy of the form to the Owner's representative as evidence of training. Training conducted without this official record of training shall not be considered as part of the Contractor's training obligation.

I. In order for all training sessions to count towards the Contractor's training obligation, each of the following shall be met.

1. Training occurs after Training Submittal review.
2. Training session outlines/agenda are distributed at each session.
3. Quality Assurance requirements for trainer have been met.
4. Training occurs after the system / section is fully complete and working (usually following final Acceptance Testing). Training in advance of this requires Designer approval.
5. Contractor fully complies with sign-in sheet requirements for every session.
6. Contractor maintains a master training log.

END OF SECTION 27 00 01

SECTION 27 05 02

BASIC MATERIALS AND METHODS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. All work performed shall be performed in accordance with all Codes applicable at the project site. The authority having jurisdiction shall have the final say as to whether code compliance has been achieved.
- B. Wherever the contractor believes, or the authority having jurisdiction advises, that work required by these contract documents is in conflict with applicable codes, the Contractor shall immediately advise and seek the direction of the Designer.

1.2 TOOLS

- A. Tools shall be used only for the purpose for which they are designed.
- B. Specialty tools shall be used for assembly, installation, termination, and removal of products as recommended by the product manufacturer.
- C. The designer reserves the right to require removal and replacement of any product installed using incorrect tools.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate installation of pathways before installation of pathways, including when pathways installation is not work of This Contractor.
- B. Review pre-existing pathways prior to installation of work and report to the Designer any discrepancies between specified pre-existing pathway conditions and actual existing pathway conditions.
- C. Coordinate with all other Contractors and the Owner, as applicable and necessary to ensure clean, professional looking and operating systems.

- D. Participate in coordination efforts through the preparation of shop drawings and details prior to fabrication or installation of any products. Coordinate actual clearance requirements of installed products.
- E. Begin coordinate immediately upon award of contract. Coordinate work with all other trades and adjust equipment locations accordingly. Refer to coordination drawings prepared by other trades; generate and supply the same for use by other trades.
- F. It is generally intended that all apparatus be located symmetrical with architectural elements and shall be installed at the heights and locations shown on the drawings. If a device height or location is in question it shall be the responsibility of the Contractor to immediately seek clarification of the Designer.
- G. The Contractor shall fully inform himself regarding all peculiarities and limitations of space available for installation of all work and materials furnished and installed under the contract. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible. Although the locations of equipment and conduit may be shown on the drawings in certain positions, the architectural details and conditions existing at the job site shall guide the Contractor, coordinating his work with that of others. Provide all necessary offsets to provide a neat workmanlike arrangement.
- H. Plans are generally diagrammatic and indicate the design intent, required sizes, points of termination and, in some cases, suggested routes of raceways, etc. However, it is not intended that plan drawings indicate fully coordinated routing and placement, all necessary offsets, etc...
- I. Contractor shall refer to all drawings, including enlarged plans, elevations, sections, and details for additional information that may include dimensions and greater resolution and notes that serve to refine the intent and further assist and guide the Contractor.
- J. The Contractor shall work in harmony with all other contractors and subcontractors performing work at the project site, so as not to cause any delays in pouring concrete, building masonry walls, etc. This Contractor shall consult ALL project drawings, including those predominately used by other trades before installing his work so as to ensure that his work will not interfere with or be adversely affected by work of other trades. This Contractor shall take all necessary steps to ensure a coordinated installation of his work.
- K. This Contractor shall attend all regularly scheduled project meetings as well as any special meetings called to coordinate and/or resolve special issues that arise during the course of the project.
- L. Conflicts in equipment and materials shall be corrected prior to installation. Should there be a conflict with drawings of other trades, this Contractor shall work with the trades to correct the conflict while coordinating the project (prior to installation). If the conflict cannot be resolved, refer the matter to the owner's representative for a final decision as to method or material. This Contractor shall refer to drawings of all other trades for details, dimensions and locations of other work and route their work so as not to conflict with any other branch. Any work installed or equipment placed in

position by this Contractor creating a conflict shall be readjusted to the satisfaction of the owner's representative at the expense of this Contractor.

3.2 INSTALLATION

A. General

1. Work installed in finished areas shall be concealed. Work installed in unfinished areas may be exposed at the discretion of the Owner's representative and approved in writing.
2. Sequence, coordinate, and integrate installations of communications materials and equipment with the work of other trades for efficient flow of the Work.
3. Install systems, materials, and equipment to conform with reviewed submittal data, including coordination drawings, to greatest extent possible.
4. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and architectural/structural components.
5. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
6. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
7. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
8. Verify all dimensions by field measurements. Take measurements and be responsible for exact size and locations of all openings required for the installation of work. Figured dimensions are reasonably accurate and should govern in setting out work. Where detailed method of installation is not indicated or where variations exist between described work and approved practice, direction of the owner's representative on job shall be followed.
9. The symbols used to indicate the purpose of various outlets is identified in the
10. Legend.
11. The conductors terminating at each wired outlet shall be left not less than 8" long at their outlet fittings to facilitate installment and servicing of devices.
12. If during construction it becomes apparent that certain minor changes in layout will affect a neater job or better arrangement, such alterations shall be made as part of the contract. Designer's review shall be obtained before making such changes.
13. Workmanship throughout shall conform to the standards of best practice. Marks, dents or finish scratches will not be permitted on any exposed materials, fixtures or fittings. Inside of panels and equipment boxes shall be left clean.
14. All termination types shall correctly match cable and device termination point.
15. As an illustration if "spade lug" type of termination is appropriate then the spade lug cable entry size should match the cable used. The spade lug shall also have the correct stud size to match the terminal to which it will be connected. Terminations shall be completed with tools designed and sized for the specific application and connector.
16. Use caution not to exceed the manufacture allowed bending radius for cables and not to compromise the integrity of the cables during installation by pulling cable management devices too tightly, damaging cables, etc. Raceway/Cabling bending radii shall be minimum as directed by cable manufacturer. Use pulling compound or lubricant, where necessary, but ensure

that the type of compound is compatible with and will not deteriorate the conductor or cable insulation.

17. Neatly dress all cable work and provide vertical and horizontal cable management (or other approved method) for properly dressing all work at racks, control panels, backboards etc. See detail(s) and other drawings for additional information.
18. Low-voltage cables shall be kept as far from electrical cables and equipment as possible. Avoid running low-voltage cables parallel to medium and high-voltage cables. When parallel runs cannot be avoided, keep low-voltage cables at least 24 inches away and cross cables at 90 degrees to minimize the risk of interference.
19. Avoid running low-voltage cables any closer than 24 inches to any ballast type lighting fixture or other high RF energy producing device.
20. All cables shall be supported/anchored at maximum 4 foot intervals and within 12" of box or outlet. All cables shall be neatly bundled and secured to discrete cable supports at four-foot intervals.
21. 12" of box or outlet. All cables shall be neatly bundled and secured to discrete cable supports at four-foot intervals.
22. Furnish color-coded cable jackets to identify runs of different systems.
23. Neatly route cables parallel and perpendicular to building architectural lines.
24. Neatly comb out multiple cable bundled runs to remove tangling and crossing of cables within the bundles.
25. All cable assemblies, etc. shall be run as straight as possible and symmetrical (perpendicular to or parallel with) with architectural items and in a consistent elevation. Work installed diagonal to building members shall not be permitted.

B. Cable Separation

1. Cables for each system shall be installed separately and isolated from cables from other systems.
2. Cables carrying signals of different types and different nominal operating levels shall be kept separated to reduce the risk of undesirable interference and cross-talk between cables.
 - a. As a general rule, for each 25dBV difference in nominal operating level between cables, Contractor shall provide at least 6 inches of separation. Example 1: cables with a 75dBV level difference between them shall be separated by 18 inches or greater. Example 2: Cables with a 13dBV difference between them shall be separated by 3 inches or greater.
 - b. Contractor shall provide additional separation to prevent and to remedy any crosstalk that adversely affects the performance and usability of the system, or that exceeds specific crosstalk performance guidelines defined elsewhere in these specifications.
3. In common areas where cables from multiple systems are run in general proximity to one another, cables from each system shall be labeled to identify the system the cables serve.

C. Cable Splices

1. Splices shall not be permitted in any cable except where expressly specified and/or approved by the Designer.
2. In cases where splices are specified and/or otherwise approved, splices shall be made within UL listed junction or device boxes. Open air connections shall not be permitted.

D. Cable Terminations

1. Where field installed cables connect to manufactured products via pig-tails or connectorized cable assemblies, all terminations shall be made within the product enclosure or within a UL approved junction or device box. Open air connections shall not be permitted. Exposed and open air splices are not acceptable.

E. Strain Relief Permanently installed cables shall be properly secured with an approved device. Strain relief shall be applied typically within 6-inches from the point of entry into a product enclosure, junction box, pull box, or device box. When properly applied the strain relief device shall not damage the cable being secured and shall not permit movement of the cable in any way that may adversely affect the long term integrity of nearby connections.

F. Identification

1. General

- a. All identification shall be in English except where otherwise noted.
- b. Where identification is applied to surfaces that require a finish, install identification after the surface finish is applied.
- c. Labeling products, color, sizes, nomenclature and the installed location of the identification product are all subject to the Designer's review and approval.

2. Cables

- a. Every installed cable shall be uniquely labeled at each end of the cable.
- b. Cables shall be labeled using permanent self-laminating type labels containing computer generated permanent type-written text.
- c. Nomenclature shall be bold-type and clearly readable by a person with average sight, and typical lighting conditions within the area of installation.
- d. Labels shall be applied approximately 6 cable-inches from the point of termination.
- e. Cables installed and intended for future use shall be clearly identified as such and the label shall clearly indicate the location of the opposite end of the cable.
- f. Every cable installed shall be recorded in the project record documents.

3. Boxes

- a. Junction boxes and pull boxes shall be labeled on their interior and on their exterior covers with the identity of the system(s) the box serves along with the function of the box. Interior markings shall be made using permanent marker. Permanent marker may also be used on the cover of boxes installed in concealed areas (above accessible ceilings for example). Exposed boxes shall be labeled with engraved plastic cables. Labels shall closely match the color of the box.
- b. Device boxes, when first installed, shall be identified on their interior with a permanent marker to identify the system(s) the box serves and to identify the device the box will contain.

4. Equipment Racks, Cabinets, Enclosures

- a. Engraved plastic labels shall be generated and applied to all equipment racks, cabinets, equipment enclosures, etc...
- b. The nomenclature, color, size, installed location, and type of all labels are subject to the Designer's review and approval.

5. System Equipment

- a. Each piece of active and passive system equipment shall be uniquely identified using labels and nomenclature acceptable to the Designer.
 - b. Front panel controls of equipment shall be labeled with nomenclature meaningful to the end user based on the intended use of the equipment in the system. Examples include, but are not limited to:
 - 1) Label router/matrix control panels with system specific input/output names.
 - 2) Label patch panels with meaningful input/output destination names
 - 3) Label mixer input and output controls to identify the signal source and destination.
 - c. Professionally prepared, installed and readily visible "cheat sheets" may be acceptable under select circumstances with the approval of the designer.
 - d. The nomenclature, color, size, installed location, and type of all labels are subject to the Designer's review and approval.
 - G. Medium and High Voltage Cabling (> 71 Volts)
 - 1. Cabling that will carry voltages higher than 71 Volts AC or DC shall be installed and terminated only by persons licensed to perform such work within the area of jurisdiction.
 - H. Plates and Panels
 - 1. Device plates/panels shall be installed flush against the surface over which the plate/panel is mounted (e.g. there shall be no visible gap between the backside of a plate/panel and the wall, ceiling or floor; there shall be no visible gap between the backside of plate/panel and a surface mount box to which the plate/panel mounts). Advanced craftsmanship and construction techniques shall be employed where necessary to achieve this.
 - a. The same shall apply to other wall and ceiling mounted products.
 - 2. Cover plates shall match finish and color of other wiring devices in this project. Refer to Section 26 27 26 "Wiring Devices" for requirements.
 - I. Device Boxes, Pull-Boxes, Junction Boxes
 - 1. Boxes installed in walls and ceilings shall be installed so that the box does not stand proud (protrude out beyond) of the finished surface. Boxes shall be installed such that when the mounted devices and cover plates are installed that the backside of the cover plate rests flush with the finished surface of the wall or ceiling. Advanced craftsmanship and construction techniques shall be employed where necessary to achieve this.
- 3.3 GROUNDING
- A. All equipment shall be properly grounded for safety and to ensure satisfactory performance of systems and equipment.
- 3.4 CUTTING, PATCHING AND SEALING
- A. General
 - 1. The Contractor shall perform all cutting as required for the admission of work.

2. Unless directed otherwise in field, provide all related patching and painting to match surrounding methods, materials and colors. Any damage done by this Contractor to the building during the progress of this Contractor's work shall be made good at this Contractor's expense. Perform cutting, fitting, and patching and materials as required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of these
 - d. Contract Documents.
 - e. Remove samples of installed Work as specified for testing.
 - f. Install equipment and materials in existing structures.
3. Upon written instructions from the owner's representative, uncover and restore work to provide for observation of concealed work by owner's representative or by inspection authority having jurisdiction.
4. During cutting and patching operations, protect adjacent installations (structure, finishes, furnishings, etc.). Where applicable, provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to system components and components of other trades.
5. Patch surfaces and building components using new materials matching existing materials and using experienced Installers. Refer to Division 1 for definition of experienced "Installer" or determine qualifications as directed in field by owner's representative.
6. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. All materials used for patching shall be installed to meet or exceed the smoke and fire rating of the respective surface being patched.
7. Neatly cut and drill all openings in walls and floors required for the installation.
8. Secure approval of Owner's Representative before cutting and drilling in existing facilities. Neatly patch all openings cut.
9. Cutting and patching shall be held to a minimum by arranging with other
10. Contractors for all sleeves and openings before construction is started.
11. Provide factory-assembled watertight wall and floor seals, of types and sizes required; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
12. Pipe sleeves shall be fabricated from Schedule 40 rigid, heavy wall, full weight galvanized steel pipe; remove burrs. Use sleeves which are two standard sizes larger than conduit passing through respective sleeve.
13. Provide sleeve seals for piping which penetrates foundation walls below grade, exterior walls or roofs, caulk between sleeve and pipe with non-toxic, UL-classified caulking material to ensure watertight seal. Elsewhere modular provide mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
14. Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, bearing walls, fire walls and masonry construction. Sleeves through walls shall be cut flush with both faces. Sleeves through floor shall extend one inch above floor top elevation. Pipes penetrating roof shall use

a pipe curb assembly equal to Pate Co. Furnish and set all forms required in masonry walls or foundation to accommodate pipes.

B. Grout

1. Provide non-shrink, nonmetallic grout, pre-mixed, factory-packaged, non-staining, non-corrosive, and non-gaseous grout, recommended for interior and exterior applications.

C. General Joint Sealer Application

1. Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
2. Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.
3. Clean all affected surfaces, joints, etc. immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
4. Apply sealant primer to substrates as recommended by manufacturer. Protect adjacent areas from spillage and migration of sealant, using masking tape. Remove tape immediately after tooling without disturbing seal.
5. Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
6. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
7. Colors for exposed seals shall be as selected by the Owner's representative from manufacturer's standard colors.

3.5 FIRESTOPPING

- A. Cables and penetrations through building walls, floor and ceilings shall be fire-stopped in accordance with Code, these specifications and related drawings.

END OF SECTION 27 05 02

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide the labor, tools, equipment, and materials necessary to furnish and install telecommunications grounding system in accordance with the plans and as specified herein. Provide all accessories as necessary for a complete system.
- B. Provide communications system-grounding conductor at point of service entrance and connect to Telecommunications Main Grounding Busbar (TMGB). Bond together the communications system grounding.
- C. This section includes the following:
 - 1. Telecommunications Main Grounding Busbar (TMGB)
 - 2. Telecommunications Grounding Busbar (TGB)
 - 3. Telecommunications Bonding Backbone (TBB)
 - 4. Telecommunications Bonding Conductor (TBC)

1.2 SUBMITTALS

- A. Product data for TMBG, TGB, and TBB.
- B. Ground resistance testing results certified by the testing organization.
- C. Schematic diagram of the telecommunications grounding system.

1.3 QUALITY ASSURANCE

- A. All equipment shall be UL listed and labeled for their intended usage.
- B. All equipment shall comply with the latest National Electric Code.
- C. All equipment shall comply with the latest TIA/EIA-607, and BICSI standards.

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- A. Provide Telecommunications Main Grounding Busbar (TMGB) in MDF Room.

- B. The TMGB shall have minimum dimensions of ¼-inch thick x 4-inch wide and 12-inch in length. The length may need to be adjusted longer to meet the application requirements with consideration of future growth. The busbar shall be UL Listed as grounding and bonding equipment.
- C. The TMGB shall be a predrilled solid copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 15 two-hole grounding lugs with 5/8" hole centers and 3 two-hole lugs with 1" hole centers. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" standoff from the wall.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- A. Provide Telecommunications Grounding Busbar (TGB) at IDF and all Communications Equipment Racks.
- B. The TGB shall have minimum dimensions of ¼-inch thick x 2-inch wide and 10-inch in length with 7 attachment points (one row). The length may need to be adjusted longer to meet the application requirements with consideration of future growth. The busbar shall be UL Listed as grounding and bonding equipment.
- C. The TGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing for the type of connectors to be used. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept 4 two-hole grounding lugs with 5/8" hole centers and 3 two-hole lugs with 1" hole centers. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" standoff from the wall.

2.3 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- A. Provide Telecommunications Bonding Backbone (TBB) between all TGBs and the TMGB.
- B. All TBB Connections to be made with double-bolted, Compression style, Grounding Lugs.
- C. The TBB shall be a minimum of #1/0 AWG insulated copper bonding conductor.

2.4 TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

- A. Provide conductors used to bond components to the TMGB and the TGBs as follows:
 - 1. Avoid unnecessary connections or splices in TBCs. When necessary, use an approved connection and position it in an accessible location.
 - 2. Typical connections are made by using: bolts or crimps (connectors, clamps, or lugs). Where possible, use irreversible compression-type connections and two-hole lugs. Always use listed hardware that has been laboratory tested.

PART 3 - EXECUTION

3.1 INSTALLATION

A. As a minimum, Bond TMGB to following:

1. Building Steel (minimum #1/0 AWG insulated copper bonding conductor). Attach Bonding Conductors to Building Steel using listed exothermic welding process.
2. Main Electrical Service Ground (minimum #1/0 AWG insulated copper bonding conductor).
3. Local Service Panel Ground.
4. Telecommunications Bonding Backbone (TBB) that connects TMGB to other TGBs (minimum #1/0 AWG insulated copper bonding conductor).
5. Associated Telecommunications Cable Tray(s).
6. Telecommunications Conduit(s) Entering TR.

B. As a minimum, Bond TGB to following:

1. Building Steel (minimum #1/0 AWG insulated copper bonding conductor). Attach Bonding Conductors to Building Steel using listed exothermic welding process.
2. Local Service Panel Ground.
3. Telecommunications Bonding Backbone (TBB) that connects TGB to other TGBs and TMGB (minimum #1/0 AWG insulated copper bonding conductor).
4. Associated Telecommunications Cable Tray(s).
5. Telecommunications Conduit(s) Entering TR (continuous minimum #6 AWG bare copper bonding conductor connecting all cable tray sections).

C. As a minimum, the Technology Contractor shall bond the following devices to the associated TMGB and TGBs using a minimum #6 AWG insulated copper bonding conductor using 2-hole compression style lugs:

1. Equipment Racks and Cabinets
2. Cable Ladder and Tray
3. Surge Protectors
4. Telecommunications Devices
5. Coupled Bonding Conductors (CBCs)
6. Backbone Cable Shields
7. Telecommunication and Fiber Cable Shields

D. General:

1. Route ground conductors to provide the shortest, most direct path from point to point. Telecommunications ground must be bonded to the lightning protection system ground.
2. Bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, the conductors shall be bonded to each end of the conduit with a conductor sized as a #6 AWG, minimum (this makes the conduit a parallel path with the cable).
3. A continuous ground path shall be provided in all telecommunications raceways. Grounded cable trays shall be considered continuous ground path.

4. At each Telecommunication Room (TR) all equipment and raceways shall be bonded to the TGB.
 5. Any grounding or bonding conductor that is run through a metallic conduit shall be bonded to the conduit.
 6. Provide dedicated Telecommunications Bonding Backbone (TBB) to interconnect the TRs and related equipment.
- E. Telecommunications Entrance Facility (TEF) Telecommunications Main Grounding Busbar (TMGB):
1. The Telecommunications Main Grounding Busbar (TMGB) serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB also serves as the central attachment point for telecommunications bonding backbones (TBB) and equipment, and is located such that it is accessible to telecommunications personnel.
 2. The TEF is the desirable location for the TMGB. This TMGB may serve as the TGB for collocated equipment in the TEF. The TMGB shall be bonded to electrical service equipment ground. This bond at the TMGB shall use a double bolted, compression style grounding lug. The bond at the electrical service equipment ground shall use an exothermically welded connection.
 3. Where an electrical panelboard is located in the same room or space as the TMGB, the ground or enclosure of that electrical panelboard shall be bonded to the TMGB. Locate the TMGB as close to the electrical panelboard as practical to maintain clearances required by applicable electrical codes.
 4. Locate the TMGB near the TBB cabling and associated terminations. The connections of the bonding conductors for telecommunications, and the TBBs to the TMGB shall utilize listed two-hole compression lugs.
 5. Telecommunications primary protector grounding conductor shall be bonded to the TMGB. A minimum of 1 foot separation shall be maintained between this insulated conductor and any DC power cables, switchboard cables, or high frequency cables, even when placed in metal raceway.
 6. All metallic raceways for telecommunications cabling located within Equipment Room (ER) shall be bonded to the TMGB. However, for metallic raceways containing grounding conductors where the raceway is bonded to the ground conductor, no additional bonding to the TMGB is required.
 7. In buildings where the backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the TMGB where the cables are terminated or where pairs are broken out.
 8. In a metal frame (structural steel) building, where the steel framework is readily accessible within or external to the mdf; each TMGB shall be bonded to the vertical steel metal frame.
- F. Telecommunications Room (TR) Telecommunications Grounding Busbar (TGB):
1. The TGB is the grounding connection point for telecommunications systems and equipment in the location served by that TR or ER. Each TR and ER shall contain a TGB. Multiple TGBs may be installed within the same TR or ER to aid in minimizing bonding conductor lengths and terminating space. In all cases, multiple TGBs within the same ER shall be bonded together with a conductor the same size as the TBB.
 2. The TGB shall be located near the TBB cabling and associated terminations.

3. The bonding conductor between a TBB and TGB shall be continuous and routed in the shortest possible straight-line path. The bonding conductor shall be the same size as the TBB.
4. All metallic raceways for telecommunications cabling located within TR shall be bonded to the TGB. However, for metallic raceways containing grounding conductors where the raceway is bonded to the ground conductor, no additional bonding to the TGB is required.
5. In buildings where the backbone telecommunications cabling incorporates a shield or metallic member, this shield or metallic member shall be bonded to the TGB where the cables are terminated or where pairs are broken out.
6. In a metal frame (structural steel) building, where the steel framework is readily accessible, each TGB shall be bonded to the vertical steel metal frame. When practicable because of shorter distances and other considerations, and where horizontal steel members are permanently electrically bonded to vertical column members, TGBs may be bonded to these horizontal members in lieu of the vertical column members.

G. Telecommunications Bonding Backbone (TBB):

1. A TBB is a conductor that interconnects all TGBs with the TMGB. A TBB's basic function is to reduce or equalize potential differences between telecommunications systems bonded to it. A TBB is not intended to serve as the only conductor providing a ground fault current return path.
2. A TBB shall be designed with consideration given to the type of building construction, the telecommunications requirements, and the configuration of the telecommunications pathways and spaces. Specifically, the design of a TBB shall:
 - a. Be consistent with the design of the telecommunications backbone cabling system.
 - b. Address routing to minimize the lengths of the TBB.
3. All TBB Connections to be made with double-bolted, Compression style, Grounding Lugs.
4. TBB conductors shall be installed without splices. Where splices are required, they shall be kept to the minimum quantity necessary, shall be accessible and located in telecommunications spaces. Joined segments of a TBB shall be connected using irreversible compression-type connectors or exothermic welding. All joints shall be adequately supported and protected from damage.

H. Telecommunications Bonding Conductors (TBC):

1. Bonding conductor sizing. The following applies to the Telecommunications Bonding Conductor (TBC):
 - a. Bonding Conductor Length (ft) / Bonding Conductor Size (AWG)
 - 1) <13 / #6
 - 2) 14-20 / #4
 - 3) 21-26 / #3
 - 4) 27-33 / #2
 - 5) 34-41 / #1
 - 6) 42-52 / #1/0
 - 7) 53-66 / #2/0
 - 8) >66 / #3/0

3.2 FIELD QUALITY CONTROL

- A. Testing Telecommunications Grounding and Bonding Infrastructure:
 - 1. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Measure ground resistance from longest grounding path to TMGB or TGB in TR or ER. Resistance shall not exceed 0.1 ohms

END OF SECTION 26 05 26

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Complete and working pathway systems for communications and related system cabling, including pathways designated as spare(s) and/or reserved for future use
 - 2. Section includes but is not necessarily limited to:
 - a. Conduit, fittings and supports
 - b. Surface raceway, fittings and supports
 - c. Discrete cable supports, fittings and supports
 - d. Cable tray, fittings and supports
 - e. Wall, floor, ceiling and roof penetrations
 - f. Miscellaneous pathway accessories

1.2 DEFINITIONS

- A. Primary Pathways – Those pathways typically located in corridors, dedicated vertical cable chases and used to enclose and/or support large quantities of compatible signal cables from one or more systems to the general area where system devices are located. Cables carried by a primary pathway transfer to secondary pathways.
- B. Secondary Pathways - Those pathways typically extending from a primary pathway to the space near the system device to be served. A secondary pathway typically accommodates 16 or less cables of compatible signals, from a single system.

1.3 SYSTEM DESCRIPTION

- A. General
 - 1. The pathway systems for communication shall consist of all products necessary to support, protect, enclose, manage and secure cables used for communications and related systems. The pathway system for each system may vary based up the requirements of these specifications and information on the drawings.
 - 2. The total pathway system shall include code-compliant penetrations through walls, floors, ceilings, roofs, etc... as necessary for the routing of cables between their intended starting and ending points.
- B. Pathway System(s) for Telecommunications (Voice/Data/Network) Cabling
 - 1. The pathway system for the Telecommunications cabling system shall be a hybrid pathway system consisting of a mixture of cable tray, conduit, discrete cable supports, conduit sleeves, and device boxes, pull boxes and junction boxes.

2. The pathway system shall be assembled from UL listed components.
3. The pathway system shall be NFPA 70 and the "National Electrical Code"
4. compliant.
5. The pathway system shall be built so that no pathway segment shall exceed a
6. 40% cable fill. Larger pathway segments (conduits, cable tray, discrete cable supports etc...) shall be provided where indicated on the drawings.
7. The pathway system shall include all products necessary to render the system usable for its intended purpose
8. The minimum conduit size permissible for use in this system shall be 1".

C. Pathway System(s) for other Communications Systems

1. General
 - a. Unless otherwise noted on the drawings, the pathway system for each of the following systems shall be a hybrid pathway system consisting of a mixture of cable tray, conduit, discrete cable supports, conduit sleeves, and device boxes, pull boxes and junction boxes.
 - b. The pathway system shall be assembled from UL listed components.
 - c. Conduit sizes used for the system shall support a cable fill percentage not exceeding 40%. Larger pathway segments (conduits, cable tray, discrete cable supports etc...) shall be provided where indicated on the drawings.
 - d. Each system shall include all products necessary to render the system usable for its intended purpose
2. Building Intercommunication Systems
 - a. Minimum conduit size for this system is 3/4".
3. Paging Systems
 - a. Minimum conduit size for this system shall be 3/4".
4. Audio/Visual Systems
 - a. Minimum conduit size is 3/4".
5. Sound Reinforcement Systems
 - a. Minimum conduit size is 3/4".
6. Pathways for other work of Division 27
 - a. Minimum conduit size is 3/4".

1.4 SUBMITTALS

A. Product Data

1. Surface Raceway
2. Cable Tray
3. Floor Boxes
4. Device Boxes
5. Box Eliminators
6. Cable Spillways
7. Discrete Cable Supports

B. Shop Drawings

1. Floor plans depicting the intended location of the following:
 - a. Primary pathways
 - b. Secondary pathways
 - c. Planned penetrations through ceilings, floors, walls and the roof.

2. Riser diagrams of each closed conduit systems used by communication systems.

C. Closeout Submittals

1. Floor plans depicting the as-installed location of the following:
 - a. Primary pathways
 - b. Secondary cabling pathways
 - c. Locations of all penetrations and conduit sleeves
 - d. Fire-rated penetration locations, along with rating value.
2. Penetration Certification Documentation
 - a. Certification paperwork for all penetrations through fire-rated building surfaces and cavities.

1.5 QUALITY ASSURANCE

- A. All products shall be UL-type listed for the location and application in which it is used.
1. All onsite personnel shall be manufacturer trained on the anchoring system being utilized.
 2. Building penetrations shall be performed by person(s) properly trained on the installation of specific rated assembly being installed.
 3. Installation material and practices shall fully comply with NFPA 70, "National Electrical Code" and ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. Conduit
1. Rigid steel conduit:
 - a. Threaded rigid steel conduit shall be manufactured from mild steel, zinc galvanized both inside and outside including threads. It shall be constructed in accordance with ANSI C80.1, Federal Specification WW-C-581;
 2. Intermediate metallic conduit:
 - a. Threaded intermediate metallic conduit shall be manufactured from mild steel, zinc galvanized both inside and outside including threads. It shall be constructed in accordance with ANSI C80.6, Federal Specification WW-C-581;
 3. Electric metallic tubing:
 - a. Electric metallic tubing shall be manufactured from mild steel, zinc galvanized both inside and outside. It shall be constructed in accordance with ANSI C80.2, Federal Specification WW-C-563;
 4. Flexible metallic conduit:
 - a. Flexible metallic conduit with neoprene jacket shall be spirally wound steel, strip zinc galvanized both inside and outside, integral ground conductor.
 5. Non-metallic raceways
 - a. Polyvinylchloride (PVC):

- 1) PVC conduit shall be virgin C300 type, Schedule 40 or 80 (90° C).
- 2) Constructed in accordance with NEMA TC2 and Federal Specifications W-C-1094A.

B. Discrete Cable Supports (J-Hooks)

1. General
 - a. Discrete cable supports with round surfaces (i.e. bridal rings) are not acceptable for use.
2. Primary Pathways
 - a. J-Hook style support.
 - b. Plenum rated construction.
 - c. Steel construction, galvanized finish
 - d. Complies with UL, cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems.
 - e. Basis of Design:
 - 1) 50 UTP Category 6 cable capacity: Erico CABLECAT32xx
 - 2) 185 UTP Category 6 cable capacity: Erico CABLECAT34xx
 - f. Additional approved manufacturers: B-Line, Panduit
 - g. See manufacturer's installation guidelines for additional quantity and sizing guidelines.
3. Secondary pathways
 - a. Plenum rated.
 - b. J-hooks style support
 - c. Steel construction, galvanized finish
 - d. Complies with UL, cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems.
 - e. Basis of Design:
 - 1) 10 UTP Category 6 cable capacity: Erico CABLECAT12xx
 - 2) 32 UTP Category 6 cable capacity: Erico CABLECAT21xx
 - f. Additional approved manufacturer(s): B-Line, Panduit
 - g. See manufacturer's installation guidelines for additional quantity and sizing guidelines.

2.2 FITTINGS

- A. Rigid steel or intermediate metallic conduit:
1. Fittings shall be threaded zinc galvanized steel.
 2. At least one bushing shall be grounding type
 - a. Equipped with a ground lug
 - b. Provide on each conduit or sleeve where surface extends below ceiling line.
- B. Electric metallic tubing:
1. Fittings shall be compression type.
 2. At least one bushing shall be grounding type
 - a. Equipped with a ground lug
 - b. Provide on each conduit or sleeve where surface extends below ceiling line.
- C. Flexible metallic conduit:

1. Fittings shall be suitable for the specific application.
 2. Use oil-tight fittings with neoprene jacketed flexible metallic conduit.
- D. Non-metallic conduit:
1. Fittings shall be of the same type and manufacturer as the raceway, connected in accordance with manufacturer's written instructions.
- E. Expansion:
1. Expansion fittings shall be of a type suitable for the particular condition and shall be complete with bonding jumper.

2.3 BOXES

A. Wall/Ceiling Outlet Style Device Boxes

1. General:
 - a. Stamped steel, code gauge, galvanized, minimum 2 ½ inches deep. Provide deeper boxes where indicated on the drawings.
 - b. Corrosion protection suitable for the atmosphere in which they are installed.
 - c. Non-gangable sheet-steel box construction
 - d. Conduit knockouts of the size and quantity and box locations required.
 - e. Threaded device mounting screw holes.
 - f. Rated for installation in the space where the box will be installed
2. Boxes Used in Masonry or Tile Walls
 - a. Galvanized steel construction
 - b. "Masonry" style box construction
 - c. Available in standard gang sizes from 1 to 6
 - d. Various depth sizes available from 2.5 to 3.5 inches
 - e. Conduit knockouts to suit the application
3. Boxes used in Gypsum Board Walls
 - a. Galvanized steel construction
 - b. "Masonry" style box construction
 - c. Available in standard gang sizes from 1 to 6
 - d. Various depth sizes available from 2.5 to 3.5 inches
 - e. Conduit knockouts to suit the application
4. Approved Manufacturers: Adalet, Appleton Electric, Bell Electric, Bowers, Eagle Electric, Mfg Co., Inc., Midland-Ross Corp., OZ/Gedney., Pass and Seymour, Inc., RACO, Hubbel, Thomas & Betts Co., Thepitt.

B. Exterior Surface Mount Outlet Style Boxes

1. Hinged cover, sized to accommodate the devices being mounted to the box.
2. Cast Aluminum construction
3. Available in standard gang sizes from 1 to 3
4. Threaded conduit hubs
5. Approved Manufacturers: Adalet, Appleton Electric, Bell Electric, Bowers, Eagle Electric, Mfg Co., Inc., Midland-Ross Corp., OZ/Gedney., Pass and Seymour, Inc., RACO, Hubbel, Thomas & Betts Co., Thepitt.

C. Surface Raceway Device Boxes

1. Designed to work with the surface raceway system to which they attach

2. Factory finished to matching the associated raceway.
3. Available in standard gang sizes of 1 to 3 gangs.
4. Sized to suit the devices they are intended to accommodate.
5. Available in a variety of box depths, including custom manufactured box depths up to 3-1/2 inches.

D. Junction and Pull boxes:

1. Conduit System Junction and Pull Boxes
 - a. Screw cover type enclosure, except where otherwise noted.
 - b. Screw covers installed in unfinished spaces, above ceilings, in utility rooms shall be provided with covers of the same finish and material construction as the box itself.
 - c. Boxes installed flush in wall shall be provided with oversize cover plates painted to match the surrounding building surface.
 - d. Boxes shall be NEMA rated for the atmospheric condition in which the box is installed.
 - e. Boxes in exterior or moist locations shall meet NEMA 3R (at minimum)
2. Surface Raceway Junction and Pull Boxes
 - a. As manufactured by the surface raceway manufacture and designed to work with the surface raceway system installed

2.4 PENETRATIONS

A. Sleeves Through Floors and Walls

1. All penetrations through floors or walls shall require a UL listed device for the purpose of penetrating the construction.
 - a. Concrete, block, brick, and gypsum drywall construction providing a fire rating of greater than one hour for walls and floors will require a UL rated sleeve assembly installed to manufacturer's requirements allowing the penetration(s) to not degrade the designed fire rating of the wall or floor.
 - 1) Basis of Design: as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Threaded Penetrator system for all fire- rated penetrations.
 - b. All other penetrations and gypsum drywall constructed walls providing a fire rating of one hour or less will require a UL rated sleeve assembly installed to manufacturer's requirements allowing the penetration(s) to not degrade the designed fire rating of the wall or floor.
 - 1) Basis of Design: as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Smooth Penetrator system for all fire-rated penetrations.
 - c. All penetrations found to be improperly sleeved after the installation of cabling will be sleeved and firestopped to restore the proper aesthetics and required fire rating to the obstruction.
 - 1) Basis of Design: as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's split-sleeve system for all fire rated penetrations.
2. Penetrations into fire rated walls with gypsum board construction.
 - a. All penetrations required in gypsum board walls for installation of horizontal cabling, where conduit is not stubbed into the ceiling cavity for

this purpose, will require a sleeved penetration through the drywall membrane or the wall cap.

- 1) Each penetration will require a UL listed sleeve assembly installed by an installer trained on proper installation of the sleeving device.
- 2) Basis of Design: as manufactured by Unique Fire Stop Products (USFP). Utilize USFP's Membrane Penetrator or Cap Penetrator system for all fire rated penetrations.
3. Basis of Design: Unique Fire Stop Products.
4. Additionally Approved: Field fabricated systems (inspected and approved by the code authority having local jurisdiction)

2.5 ACCESSORIES

A. Pull Strings

1. Pull strings shall be nylon type as manufactured by Arnco or approved equal.
2. Additional Approved Manufacturers: Greenlee, Condux

B. Fiber Optic Inner Duct

1. NEMA TC 5, UL listed, corrugated, specifically designed for optical fiber cable pathways.
 - a. Color : Orange
 - b. 1-inch minimum inside diameter
 - c. 600 pounds minimum pulling strength
 - d. Factory installed pull rope
 - e. Rated for the environment in which it is installed.
 - f. Riser Rated Environments:
 - 1) Basis of Design: Carlon DF4X1C-xxxx
 - g. Plenum Rated Environments:
 - 1) Carlon CF4X1C-xxxx for installation in Plenum environments.
 - h. Additional Approved Manufacturers: Arnco, Endot, Opti-Com, Pyramid

C. Cable Spillways

1. On 4-Inch Sleeves
 - a. Cable Management Corp. Model CM-1004 Cable Spillway.
 - b. Additional Approved Manufacturers: B-Line, Chatsworth
2. On 2-Inch Sleeves
 - a. Cable Management Corp. Model CM-1002 Cable Spillway on two-inch sleeves.
 - b. Additional Approved Manufacturers: B-Line, Chatsworth

D. Supports

1. General
 - a. Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.
 - b. Products used outdoors shall be hot-dip galvanized.
2. Material Types
 - a. Concrete and Masonry Anchors:
 - 1) Basis of Design: As manufactured Hilti, or approved equal.
 - b. Raceway Supports:

- 1) Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
 - c. Fasteners:
 - 1) Types, materials, and construction features as follows:
 - a) Expansion anchors: Carbon steel wedge or sleeve type
 - b) Toggle bolts: All steel springhead type
 - c) Powder-driven threaded studs: Heat-treated steel, designed specifically for the intended service
 - d. Conduit Sealing Bushings:
 - 1) Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
 - e. Cable supports for vertical conduit:
 - 1) Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits.
 - 2) Furnish with plugs with the number and size of conductor gripping holes as required to suit each individual application.
 - 3) Body construction: Malleable-iron casting with hot-dip galvanized finish.
 - f. Threaded Rod Stock (All-Thread Rod)
 - 1) Available in 1/4", 3/8", 1/2", and 5/8" sizes.
 - 2) Rod lengths over 6' will require a "Rod Stiffener" installation for 1/2" and 5/8" rods.
 - a) A section of U-Channel stock is placed around the rod and stiffener clamp assemblies used to clamp to rod.
 - b) Place clamps a minimum of 6" from the top and bottom of the rod and every 18" in between.
 - c) Basis of Design: B-Line SC228
 Additional approved manufacturer(s):
 Unistrut Diversified Products
 GS Metals Corp.
 Haydon, Corp.
 Kin-Line Inc.
 - g. Slotted Met
 - 1) 16-gauge steel channels, with 9/16 inch diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.
 - 2) Basis of Design: Unistrut Diversified Products
 - 3) Additional Approved Manufacturers: Allied Tube & Conduit, American Electric, B-Line Systems, Inc., Cinch Clamp Co., Inc., GS Metals Corp., Haydon Corp., Kin-Line Inc.
- E. Bushing, Knockout Closures and Locknuts
1. Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate the layout and installation of raceway and boxes with the work of this and other Divisions; work of other trades; and with existing construction elements to ensure adequate headroom, working clearances, and to allow for post installation access.

3.2 INSTALLATION

A. General

- 1. Size all new pathways so as to ensure maximum fill ratios will not be exceeded when the systems cabling they serve is installed. Where drawings indicate the use of larger conduit sizes, install the larger sizes as indicated.
- 2. Install above-grade raceways, and cable tray parallel to and/or perpendicular to building elements.
- 3. Install pathways level, except where elevations changes are required for installation.

B. Raceways

- 1. Except as otherwise noted and/or detailed on the drawings, install the following types of raceways as defined below
 - a. Rigid Galvanized Steel (GRC):
 - 1) Above grade, outside the building envelope, in exposed areas.
 - 2) Above grade, inside the building envelope, in high moisture areas.
 - b. Electric Metallic Tubing (EMT):
 - 1) Within the building envelope.
 - c. Polyvinylchloride (PVC):
 - 1) Below grade (except where otherwise noted on the drawings).
 - d. Flexible Metal Conduit (FMC):
 - 1) Flexible metal conduit shall only be used between a secondary pathway and a device location and shall only be used where it is expressly indicated on the drawings.
 - 2) Maximum length of any FMC path shall not exceed 6 meters.
- 2. Conduit
 - a. Install all conduit terminations with locknuts and bushings. Provide conduits 1 ½ inches and larger with insulating bushings and locknuts inside and outside the enclosure.
 - 1) At least one bushing per conduit shall be grounding type, equipped with a grounding lug.
 - 2) Ground conduit system required by code and in accordance with the grounding and bonding specifications and related drawings.
 - b. Support conduits by pipe straps or trapeze hangers. Space supports not more than 8 feet on center. Secure supports by means of toggle bolts, inserts or expansion bolts.
 - c. Space wall brackets supporting conduits not more than 4 feet 6 inches on center. Secure supports by means of toggle bolts, inserts or expansion bolts.

- d. Support raceway components directly from structural building systems, not from ceiling suspensions systems. Provide supplemental supports for junction or pull boxes.
- e. Conceal conduit raceways under floors, in walls, above ceilings and in furred spaces within finishes building areas.
- f. Support single conduits 1 ½ inches and larger by means of rod and cast ring hangers. Support multiple runs in similar manner or use common trapeze hanger.
- g. Provide two-hole sheet metal pipe straps for all surface mounted conduit supports on walls up to a height of 8 feet above the finished floor.
- h. Pinch type hangers similar to minerallac type shall only be used at heights greater than 8 feet.
- i. Protect conduits during construction with temporary plugs or caps.
- j. Securely cap all conduits until wire or cable is installed. Do not install conduit in concrete slab.
- k. Provide expansion fittings where raceway crosses the building expansion joints. (O.X. Type AX, EX, EXDS, TX, EXE, or approved equal).
- l. Conduit Routing
 - 1) If specific routing information appears on the drawings, route and maintain conduits as shown. Should interference or conflict arise, the Contractor shall inform the Designer before proceeding with the Work.
 - 2) If specific routing information does not appear on the Drawings, Contractor shall determine the best route for the conduit in accordance with code and other specified guidelines.
- m. Conduit bends
 - 1) Bends shall be made so that the conduit will not be flattened or kinked and the internal diameter of the conduit will not be reduced.
 - 2) The radius of the curve of the inner edge of any bend shall not be less than as indicated by the National Electrical Code and ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 3) In no case shall any conduit be bent or shall any fabricated elbow be applied to less than the allowable bending radius as specified by the cable manufacturer of the installed conductor.
 - 4) When necessary to make field bends, use tools designed for conduit bending.
 - a) Heating of metallic conduit to facilitate bending is not permitted.
 - 5) Constructing an outside entrance to a building from buried conduit to penetrate above the ceiling line will allow an exception for a 4" LB fitting at one end to allow placement of the conduit flat to the building outside wall.
- n. The Contractor shall not cut, burn, or drill any structural member to mount electrical equipment or to facilitate tray or conduit installations without having previously received approval, in writing, from the Architect/Engineer/Consultant.
- o. Install above-ceiling conduits a minimum of 7 inches above ceiling tiles so as to permit ceiling tile removal
- p. Install conduits at least 6 inches from insulated pipes, steam lines or any other hot pipes they pass. Where the lines are not insulated, the

clearances shall be increased until the temperature of the conduit, with no live conductors enclosed, does not rise above the ambient temperature of the installation area.

- q. Conceal all raceways except where otherwise indicated.
 - r. Install flashing and counter flashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc. that penetrate the roof.
 - s. Install sleeves in forms for new concrete walls, floor slabs, and partitions for passage of raceways.
 - 1) Seal sleeves in an approved manner that pass through fire rated walls, floors, and ceilings, following raceway installation.
 - t. Waterproof all sleeved raceways in areas prone to high moisture and condensation.
3. Surface Raceway
- a. Install surface raceway in areas indicated on drawings.
 - b. Coordinate installation with casework prior to the installation of casework and raceway.
 - c. Install raceway, accessories and device boxes plumb and level.
 - d. Anchor raceways to walls with the anchors designed for the wall construction encountered.
 - e. Secure raceway at intervals of not more than 2 feet, and not less than 6 inches from the ends of each raceway.
 - f. Install raceway per the manufacturer's written recommendation, including necessary entrance, ending and bend fittings.
 - g. Furnish and install all of the manufacturer's recommended fittings and accessories.
 - h. Where surface raceway is provided for a secondary pathway from the outlet to the ceiling space, extend surface raceway into the ceiling space not less than 4 inches.
4. Pull Boxes
- a. Install all pull boxes as indicated on the drawings.
 - b. Install pull boxes every 180 degrees of conduit bends
 - c. Install pull boxes within the building every 100 feet of conduit.
 - d. Install pull boxes for underground conduits at intervals not more than 600 feet of conduit. Install more frequently as required by Code.
 - e. Install pull boxes in areas that will be accessible after installation.
 - 1) Accessible areas include above accessible ceiling, snap-in ceilings, and behind access doors.
 - f. Support and size boxes in accordance with the N.E.C.
 - g. Land conduits on the box so conduit entry will permit the longest radius for conductors contained therein.
 - h. Provide junction and pull boxes such that conduits enter and exit across from each other on opposite sides of the junction box.
 - i. Do not use pull boxes in lieu of conduit bends.
- C. Pull Stings
- 1. Install a usable pull string in every pathway prior to the installation of cables.
 - 2. This string shall be used to aid in the installation of system cables.
 - 3. Install a usable pull string each pathway during the installation of cable(s) within the pathway. This string be tied off and shall remain available for future use.
- D. Inner Duct

1. Install appropriately sized inner duct in all pathways that will be used to enclose and support fiber optic cables.
 - a. Inner duct is not required in those pathways containing exclusively Armored-type fiber optic cables.
 2. Plenum rated inner duct shall be used in pathways that are not 100% conduit.
- E. Spillways
1. Install cable spillways where cabling exits a conduit sleeve, cable tray, etc. where cable(s) will be unsupported for more than six inches.
- F. Telecommunications / Power Poles
1. Mount straight and anchor to building structure above the ceiling line.
 2. Provide mounting hardware, entrance end fitting, and ceiling trim plate.
 3. Coordination and Positioning
 - a. Coordinate positioning with other trades to assure maximum accessibility.
 - 1) Tray shall be mounted securely along the wall at a minimum of 6" (lower tier) above the ceiling line.
 - 2) Where two 12" trays connect to a two tier unit, the upper tray may continue at 12" (upper tier) above the accessible ceiling.
 - 3) Where tray cannot be wall mounted, (transversing hallways, etc.) mount span securely to wall at each end and provide 1/2" threaded rod supports, anchored into the concrete deck above, every 4' at minimum.
 - 4) Minimum access should be 12 inches clear above the tray (each tier) and 12 inches clear beside the tray to facilitate moves, adds and changes for telecommunications cabling.
- G. Discreet Cable Supports (J-Hooks)
1. Discrete cable supports shall be installed to support cables in areas that are readily accessible after installation (example: above accessible suspended ceiling).
 2. Enclosed raceways systems shall be used in lieu of discrete cable supports where cables must pass through inaccessible areas.
 3. Install separate supports for cables from every system, and install separate supports for incompatible cables from the same system. Array supports vertically using the appropriate spacing.
 4. Attach supports directly to vertical building surfaces, or from overhead structural members using threaded rod and other approved attachment methods.
 5. Install supports plumb and square.
 6. Mount bottom of supports approximately 12" above suspended ceilings.
 7. Cable supports shall be installed at intervals not exceeding 5' feet.
 8. Adjacent supports shall be installed at the same elevation except where necessary for coordination with other trades and pathways of other systems.
 9. Install supports so that they do not interfere with the ability to remove ceiling tiles.
 10. Support with threaded rod and U-channel supports systems.
 11. Discrete Support Sizing and Quantity
 - a. Do not exceed 75% of the permissible fill capacity of any support provided.
 - b. Install multiple supports as required to handle the total quantity, size and type of cables served.

- c. After installation of cables, 25% of rated permissible fill capacity shall be reserved for future use.
- 12. Discrete Support Usage and Quantity
 - a. Use separate supports for cables from different systems
 - b. Use separate supports to carry cables of incompatible signals from the same system.

H. Device Boxes

- 1. New-work and old-work device boxes shall be installed flush with or slightly recessed below the finished surface (but no more than code allow, nor more than .078-inches (2mm)). Old work boxes require advanced craftsmanship and construction techniques to achieve this.
- 2. Installed height of boxes shall generally be as indicated on the drawings. Installed heights shall be adjusted in the field to ensure a clean appearance that results from coordinating with existing installed box heights and new boxes being installed to serve non-communications systems. Where the specified box height and existing condition boxes differ by more than 2-inches, seek the direction of the Designer prior to installation.
- 3. Device boxes and their associated cover plates shall not span different types of wall finishes either vertically or horizontally. Horizontal and vertical position of boxes shall be adjusted at time of installation to ensure that this condition does not exist after installation.
- 4. Boxes in masonry shall be installed so that the specified cover plates will cover the mortar joints and cut openings completely.
- 5. Device boxes shall be installed so that they are securely and rigidly attached to the building by any of the following methods:
 - a. Double bar installation for metal stud walls. Bar hanger punch, mounting clips, and retainer clips shall be used in strict accordance with manufacturer's instructions. Factory pre-punched stud holes shall not be used to support the bar hangers.
 - b. Steel stud installed behind box for support without "caddy-type" mounting clips for metal stud wall construction.
 - c. "Caddy-type" screw gun bracket installed behind box for support. Installation shall be per manufacturer's instructions.
- 6. Device boxes shall not rely on the raceway as their primary means of support. Boxes shall be attached to surrounding building structure.
- 7. Device boxes shall be installed plumb and level, held to within all of the following limits:
 - a. Maximum one-tenth (1/10) of one degree from plumb and from level, and;
 - b. Maximum difference from level of .078-inches (2mm) at one end of the box relative to the other end of the box, and;
 - c. Maximum difference from plumb of .078-inches (2mm) at the top of the box relative to the bottom of the box;
- 8. Boxes shall be shimmed as necessary to insure level and plumb installation.
- 9. Install gaskets on all boxes installed outside and in wet or damp locations (tunnels, crawlspaces, pits, etc.).
- 10. Device boxes shall be protected from plaster.
- 11. Floor boxes shall be installed flush and true with the finished floor.
- 12. Boxes shall be cleaned of debris after installation.
- 13. Boxes shall be cleaned of debris thoroughly prior to installation of cover plates;
- 14. Install blank cover plates on each unused device box.

I. Penetrations

1. Sleeves Through Floors and Walls

- a. Install conduit sleeves where indicated on the drawings and wherever cables or raceways will pass through floors, walls, ceilings, and any concrete or masonry structure, except where tunnels, chases or shafts are provided in the project site construction.
 - 1) Sleeves through poured-in-place concrete surfaces shall be set in place prior to the concrete pour and shall be of a design that seals against the passage of water between the sleeves and concrete floor.
- b. Install cable protecting bushings on the each end of each sleeve.
- c. Extend all through-the-wall sleeves a minimum of 2 inches beyond the wall surface, longer as required, to allow installation of conduit bushings.
- d. Extend through-the-floor sleeves 4 to 6 inches above finished floors, except where otherwise noted on the drawings.
- e. Voids between the sleeve and the building surface shall be neatly finished and filled with approved fire stop material.

2. Labeling

- a. Install penetration certification next to each penetration through fire-rated surfaces.

J. Supports

1. Fabricated Supporting Devices

- a. Conform to the manufacturer's recommendations for selection and installation of supports.
- b. The strength of each support shall be adequate to carry present and planned future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs. provide additional strength until there is a minimum of 200 lbs. safety allowance in the strength of each support.
- c. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
- d. Support parallel runs of horizontal raceways together on trapeze-type hangers.
- e. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners shall be used in lieu of hangers for 1 ½ inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only.
- f. For hanger rods with spring steel fasteners, use ¼ inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
- g. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings shall be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
- h. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

2. Miscellaneous supports

- a. Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, pull boxes, junction boxes, and other devices.
 - b. Support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- 3. Fastening:
 - a. Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to; conduits, raceways, cables, cable traps, busways, cabinets, panel boards, transformers, boxes, disconnect switches, and control components in accordance with the following:
 - 1) Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts shall be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - 2) Holes cut to depth of more than 1 ½ inch in reinforced concrete beams or to depth of more than ¾ inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 - 3) Ensure that the load applied to any fasteners does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
 - b. Raceway supports: Hanger spacing shall be as required for proper and adequate support of the raceway, but in no case shall be less than one hanger per 5 feet of raceway length.

K. Ground and Bonding

- 1. Ground and bond raceway systems in accordance with the NEC and ANSI/TIA/EIA 607. See Related Drawings and Specifications for additional information.

3.3 TRAINING

- A. Review the pathway system(s) with the Owner's facility management personnel, and other owner designated personnel responsible for ongoing maintenance of systems installed within the pathways.
- B. Review all key pathway paths and expansion capabilities

END OF SECTION 27 05 28

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SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Labeling of Communications Systems, Equipment and Rooms
 - 2. System includes but is not limited to:
 - a. Communications product identification labels
 - b. Communications room labels
 - c. Communications Key Drawings

1.2 REFERENCES

- A. ANSI/TIA/EIA-606 – The Administrative Standard for the Telecommunications Infrastructure of Commercial Building.
- B. “TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL” published by the Building Industry Consulting Services International (BICSI).

1.3 SYSTEM DESCRIPTION

- A. Identification of Communications shall consist of professionally created and applied labeling products for the following types of Communications products.
 - 1. Cabling
 - 2. Equipment racks
 - 3. Equipment enclosures
 - 4. Patch panels
 - 5. Device plates
 - 6. Communications equipment room(s)
 - 7. Communications cabling, including horizontal and backbone cabling
 - 8. Communications cabling cross-connects
 - 9. Communications backboards
- B. The labeling schema used for structured cabling shall be an ANSI/TIA/EIA-606 compliant system - The Administrative Standard for the Telecommunications Infrastructure of Commercial Building Identification System. See Related Drawings for graphical representation.
- C. Each communications room shall be equipped with a set of unique Key Drawings that shall identify the installed location of communications devices served out of and interconnected to the communications room. The drawings shall include identifiers that

uniquely associated field devices with specific termination products within the Communications room.

1.4 SUBMITTALS

- A. General
 - 1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal.
- B. Product Data
 - 1. Manufacture datasheets for all products.
- C. Shop Drawings
 - 1. Labeling system diagram, detailed.
 - 2. Communications room wall elevation drawings indicated the size, title and location of all Key Drawings.
- D. Communications Room Key Drawings
 - 1. (2) full size copies of the Communications Room Key Drawings
 - a. These drawings should be submitted for review by the Designer with or prior to the pre-acceptance submittal.
- E. Closeout Submittals
 - 1. A diagram of the labeling schema used on the Project.
 - 2. Copies of Communications Room Key Drawings

PART 2 - PRODUCTS

2.1 GENERAL

- A. All products used for labeling and identification of communications systems shall be reviewed and approved by the Designer prior to installation.

2.2 MANUFACTURERS

- A. Products equal to the Basis of Design products from the following manufacturers may be used on this project:
 - 1. Panduit
 - 2. Hellerman/Tyton
 - 3. Brother
 - 4. Thomas and Betts

2.3 LABELS

- A. Cable Labels
 - 1. Cable labels shall permanent, self laminating type.
 - 2. Labels shall have a white background for text, and bold black nomenclature.

3. Provide alphanumeric, clearly typewritten labels at all designated points as follows:
 - a. Horizontal Cables
 - 1) 4 pair UTP cables
 - a) Basis of Design: Brady PTL-31-642
 - 2) 4 pair STP cables
 - a) Basis of Design: Brady PTL-21-642
 - 3) Coaxial cables
 - a) Basis of Design: Brady PTL-31-642
 - b. Backbone cables
 - 1) 100 pair Copper cables
 - a) Basis of Design: Brady PTL-34-642
 - 2) Fiber Optic Cables
 - a) Basis of Design: Brady PTL-21-642
 - 3) Cable Bundles
 - a) Basis of Design: Brady PTL-12-109

B. Miscellaneous Product Labels

1. Telecommunications outlet port
 - a. Basis of Design: Panduit PLL-46-Y2-1
2. Telecommunications outlet faceplate
 - a. Basis of Design: Panduit JLEFPS-1
3. Patch panel ports
 - a. Basis of Design: Panduit JLCPL-1
4. Patch Panels
 - a. Basis of Design: Brady PTL-20-422
5. 110 style blocks
 - a. Basis of Design: Panduit DSL-110
 - b. Use with Panduit P110LH
6. Communications Backboards
 - a. Basis of Design: Brady PTL-37-422
7. Racks and Cabinets
 - a. Basis of Design: Brady PTL-42-422

2.4 KEY DRAWINGS

1. Key drawings shall be professional produced by the Contractor.
2. Drawings shall be produced to include floor plans drawing to scale, typically at 1/8-inch = 1-foot, unless otherwise approved by the Designer.
3. Key drawing size shall be in direct proportion to the size of the space represented, but in not case larger than 24-inches by 36-inches.
4. Drawings shall be prepared on a 20lb bond paper substrate.
5. The key drawing information shall be produced in color. The color scheme shall be as follows.
 - a. Paper background: White
 - b. Floor plan layout: Light gray / faded black
 - c. The colors of all drawing system associated with each system shall be unique.
6. Key Drawing Protective Overlay
 - a. 1/8" Clear Plastic
 - b. Size: 2-inches wider and 2-inches taller than the key drawings it protects.

- c. Pre-drilled with mounting screw clearance holes
 - 1) Mounting holes shall be place 1/2-inch from the overlay edge and 1/2-inch from the drawing the overlay protects.
 - 2) Mounting holes shall exist in each corner of the overlay
 - 3) Mounting holes shall exist along the vertical and horizontal edges, uniformly spaced no more than 18-inches on center.
- 7. Key drawings shall be prepared for each system and for each Communications room.
- 8. All key drawings shall have the same quality appearance. Colors, font type and properties shall be consistent and shall appear as though they were all prepared by the same professional organization.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Labels

- 1. General
 - a. Apply all labels so that they are installed parallel to the dominant visual lines of the product being labeled.
 - b. Labels shall be clearly legible and appropriately sized for the application.
- 2. Cable Labels
 - a. Horizontal structured cabling:
 - 1) Cabling to ER/TR from outlets and devices
 - a) ER/TR # - Patch Panel #/Port # - Outlet Room Number.
 - b) Example: ER01-211-B22 where Equipment Room is identified as ER01, the cable travels to room 211 and the cable is landed on patch panel B position 22 (of 48) in the ER.
 - c) Locate label on cable jacket between 3 and 6 inches of each end of the cable.
 - 2) Cabling between horizontal outlets/devices
 - a) Label local input cables.
 - b) Locate label on cable jacket between 3 and 6 inches of each end of the cable.
 - c) Label each cable as to its signal type, purpose, and destination. Add a numeric suffix to uniquely identify multiple cables of duplicate signal type, purpose or destination.
- 3. Miscellaneous Product Labels
 - a. Telecommunications outlet ports and faceplates:
 - 1) ER/TR# - Outlet Room Number – Patch panel #/ Jack #.
 - 2) Example: ER01-211 faceplate number and B22 through B25 jack numbers for a 4 port faceplate where Equipment Room is identified as ER01, the cable is landed on patch panel B position 22 through 25 (of 48) in the ER and travels to room 211.
 - 3) Locate the faceplate label, excluding the jack designation at the top of the faceplate. Locate the individual jack designation numbers immediately above each jack on the faceplate.
 - b. Patch panels and patch panel ports:

- 1) Label each patch panel A-Z, top-to-bottom
 - a) Locate label on the front upper left corner of all patch panels
- 2) Locate on the front of all patch panels, directly above or below (as indicated by the manufacturer) each jack position (1 through 48) in the patch panel; place the room number corresponding to the room number used on the faceplate for each port.
- 3) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate schema.
- c. Backbone cabling:
 - 1) Service designation – ER#/TR#.
 - 2) Service designation – CB = Copper Backbone, FB = Fiber
 - 3) Backbone, VB = Video Backbone. Example: CB – ER01/TR02.
 - 4) Locate label on cable jacket within 6 inches of each end of the cable and at key pull points along pathway.
- d. Cross-connect blocks, 110 style
 - 1) Locate on the front of all blocks directly above or below (as indicated by the manufacturer) each position in the block.
 - 2) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate scheme or opposite end labeling dependant on use.
 - 3) Label the upper left corner of each block designating the service of that particular block. Do not terminate mixed services on the same block.
- e. Cross-connect blocks, 66 style
 - 1) Locate on the front of all blocks directly above or below (as indicated by the manufacturer) each position in the block.
 - 2) Labeling shall be in numerical order and correspond to the telecommunications outlet faceplate scheme or opposite end labeling dependant on use.
 - 3) Label the upper left corner of each block designating the service of that particular block. Do not terminate mixed services on the same block.
- f. Communications Backboards (TBB)
 - 1) Backboard # with the prefix TBB, followed by the numeric backboard number in the room, followed by the suffix identifying the room in which the backboard is located. Example: TBB–01-ER-xxx.
 - 2) Label each 4'x8' sheet and each partial sheet, in numerical order left-to-right as facing the front of the backboards.
- g. Equipment Racks
 - 1) Device ID. Example: ER01.02.
 - 2) Label each cabinet/rack in numerical order left-to-right as facing front of cabinet/rack bays.
- h. Telephone Patch Cables
 - 1) Labeled with the same unique identifier at both ends of the assembly.

B. Key Drawings

1. Install Key drawings within each Communications room.
2. Create and install separate drawings, for each system. Voice and data systems may occupy the same key drawing.

3. Install key drawings where they will be readily accessible, visible and legible by Owner personnel.
 - a. Normally, drawings shall be installed so that the top edge of the drawing(s) is at 72-inches above finished floor. If this height is not achievable the Contractor shall make recommendations to and seek the direction of the Designer.
4. Separate Key Drawings shall be prepared for each system, including but not limited to:
 - a. Voice (Telephone) and Data (Network) communication systems RF Broadband Video Distribution Systems (CATV/SMATV/MATV)
 - b. Security Systems (Video Surveillance, AccessControl, Intrusion Detection, etc...)
 - c. Other systems as specified in this Division.

3.2 TRAINING

- A. Conduct a walk through of the project site and demonstrate the presence and location of all key labeling elements used.
- B. Demonstrate the accuracy of these Key drawings to the Owner by having the Owner randomly select devices on the key drawings followed by this Contractor showing the physical location and coordinated labeling of the actual field devices.
- C. Furnish handouts to all owner personnel attending training that clearly depicts the labeling schema used on the project.

END OF SECTION 27 05 53

SECTION 27 11 16

COMMUNICATION CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Supply and installation of equipment racks, cabinets, frames, enclosures and related accessories.

1.2 DEFINITIONS

- A. Where the term "Equipment Rack", or "Rack", in either it's singular or plural form, as utilized within this specification(s) and on the drawings is intended to generically refer to products designed for and normally used to house and/or mount 19", 23" and 25" E.I.A. standard "rack mounted" equipment. These "Racks" come in multiple forms, sizes, styles and finishes including but not limited to the following:
 - 1. Cabinet Types
 - 2. Open Frame/Relay Types
 - 3. In-Wall Types
 - 4. Wall Mounted Types
 - 5. Swinging Types
 - 6. Portable and Roll around Types
 - 7. ATA Types
 - 8. Miscellaneous specialty types

1.3 SUBMITTALS

- A. General
 - 1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal.
- B. Product Data
 - 1. Complete Bill of Materials (BOM) List
 - a. The BOM shall be organized (i.e. "sub-grouped") by Device ID.
 - b. Under each Device ID the Contractor shall enumerate the quantity, brand and model of every product to be supplied associated with each Device ID.
 - c. The manufacturer's name (Brand) and full model number shall be used. (Distributor and Contractor assigned names and model numbers are unacceptable).
 - d. Adjacent to the Device ID the Contractor shall clearly indicate the following:
 - 1) The Rack Type (as identified within these specifications)
 - 2) The room name and number in which the rack is to be located.

- 3) The system(s) that the rack supports
2. Manufacturer Product Datasheet for each product.
 - a. Product datasheets shall be manufacturer originals, or first generation printed versions of manufacturer's official electronic product sheets.
 - b. Manufacture model shall be highlighted on each sheet.
 - c. Datasheets shall be organized to match the order and organization of this section
- C. Shop Drawings
 1. $\frac{1}{2}" = 1'0"$ enlarged plans of each space that houses one or more equipment rack(s) and related accessory products. Seek the direction of the Designer if a scale other than this is necessary to make the plan(s) fit on the specified sizes of paper.
 - a. Drawings shall be reproduced on 11" x 17" paper,
 - 1) Drawings shall be reinforced, folded and bound into the rear of the submittal binder.
 - 2) Each drawing shall reflect a single room.
 - b. Drawings shall clearly reflect the unique Device ID assigned to the rack.
 2. Full Scale drawings of the labels that will be affixed to each equipment racks.
- D. Quality Assurance / Control Submittals
 1. RCDD Certification for the staff member responsible for this project.
 2. Resume of the last 10 projects of the RCDD responsible for this project
 3. BICSI Technician's certificate for each lead Technician(s) on the project
- E. Closeout Submittals
 1. Communication Room enlarged Floorplan Layouts, drawing to scale, depicting device sizes and locations..
 2. A diagram of the labeling scheme used on the Project.

1.4 DELIVERY, STORAGE AND HANDLING

- A. This contractor shall coordinate the delivery location and timing of delivery of product to the project site and/or other contractor's pre-assembly site(s) as necessary to meet the needs of contractors utilizing product supplied under this section.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. General
 1. All racks shall be UL Listed for the location and manner in which the product will be installed and used.
 2. All products furnished of a given type under this section shall be manufactured by a single manufacturer; shall bear the same brand name; shall be of the same finish color and texture; and shall be from the same product model series, unless otherwise noted.

3. Accessories furnished for use with an equipment rack shall be from the same manufacture as the rack, except where unless otherwise specified and/or indicated on the drawings
4. All equipment racks and their accessories shall be furnished black in color unless otherwise expressly identified herein or noted on the drawings.
5. All racks located adjacent to one another shall be matching in size, color, fit and finish texture, and shall be manufactured by the same manufacturer except where otherwise expressly required by the Designer.
6. All racks located within eye-sight of one another shall be matching in color, finish texture, and as manufactured by the same manufacture except where otherwise expressly required by the Designer.

B. Substitute Racks

1. Substitute equipment racks may not exceed the physical dimensions of the specified equipment racks, nor may they be less then $\frac{1}{2}$ inches less in any external dimension without the model specific pre-bid written approval of the Designer.

C. Rack Side Panels

1. Where equipment racks require accessory side panels, and where these racks are detailed on the drawings to be "ganged" together, only one set of side panels is required to be furnished for each model of rack in the gang.

2.2 EQUIPMENT RACKS

A. Floor Type

1. Description
 - a. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - b. Material: Extruded aluminum.
 - c. Four-post: minimum 1000lbs load rating.
 - d. Overall height: as shown on drawings.
 - e. Depth: minimum 23 inches.
 - f. Rack units: as shown on drawings.
 - g. Finish: Manufacturer's standard, baked-polyester powder coat.
 - a) Color: Black.
 - h. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug and power distribution units (PDU).
 - i. Base shall have a minimum of four mounting holes for permanent attachment to floor.
 - j. Top shall have provisions for attaching to cable tray or ceiling.
 - a) Self-leveling
 - k. Approved Manufacturer: Panduit.
 - l. Additional approved manufacturer(s): Great Lakes, Chatsworth, Hubbell.

2.3 RACK ACCESSORIES

A. Storage Drawer

1. Accessory key lock.

2. Sizes and quantity as indicated and/or scaled from drawings.
- B. Filler Panels
1. General
 - a. Provide quantity of filler panels as required to filling all unused spaces of every supplied equipment rack not occupied by a supplied product specified in another section or as shown on the Detail Drawings.
 - b. Except where shown on the drawings, all furnished filler panels shall not exceed 2-rack units (3.5 inches) in height.
 - c. Provide appropriate mixture of vent-type and blank-type filler panels as required to ensure proper air-flow and equipment cooling.
 2. Vent-Type
 - a. 16-Gauge steel construction
 - b. Vertical vent slot orientation
 - c. Textured powder coat finish
 - d. Flanged upper and lower edges for rigidity.
 3. Blank-Type
 - a. 16-Gauge steel construction
 - b. Textured powder coat finish
 - c. Flanged upper and lower edges for rigidity.
- C. Rack Mount Shelves – (for use in Voice/Data/Network Racks only)
1. Basis of Design: Homaco ESV-19-4B
 2. Sizes and quantity as indicated and/or scaled from drawings.
- D. Rack Mounted Shelves – Custom (used for Audio, Video and Security Systems Equipment)
1. 16-Gauge steel construction
 2. Textured powder coat finish
 3. Form-fitted front panel sized to exactly match the products hosted on the shelf
 4. Custom sized in standard EIA Rack unit heights to match the equipment hosted on the shelf.
 5. Quantity: Furnish quantity and size of custom shelves required to accommodate all equipment to be mounted that is neither supplied with nor available from the product manufacturer with a rack mount accessory kit.
- E. Rack Mounting Screws
1. Truss-type screw head
 2. Black finish
 3. Matching size and color nylon protective washer
 4. For Racks with #10-32 threaded rack rails
 - a. #10-32 thread
 - 1) Furnish (3) Phillips-drive screw/per rack space/per supplied rack.
 - 2) Furnish (1) Square-post security drive screw/per rack space/per supplied rack.
 5. For Racks with #12-24 threaded rack rails
 - a. #12-24 thread
 - 1) Furnish (4) Phillips-drive screw/per rack space/per supplied rack.

2.4 LABELS

- A. Equipment Racks
 - 1. Label shall be white polyester.
 - 2. Label shall have temperature range of -40 to 248 degrees F
 - 3. Label shall have superior adhesion and utilize thermal transfer
 - 4. Label shall utilize 3/4" black font
 - a. Basis of Design: Brady PTL-100-483

PART 3 - EXECUTION

3.1 COORIDINATION

- A. This Contractor shall coordinate closely with all Contractors/sub-contractors/vendors supplying work within supplied product. This coordination shall include review of equipment rack configurations to ensure that they appropriately complement the systems being supplied;
- B. This Contractor shall coordinate the delivery of product and its installation to meet the workflow of contractors, sub-contractors and this project as a whole.

3.2 INSTALLATION

- A. Equipment Racks
 - 1. General
 - a. Secure all fixed position, non-portable equipment racks using removable threaded fasteners to prevent equipment racks from movement and tipping over.
 - b. Bond all equipment racks to the Telecommunications System Ground.
 - c. Properly secure racks to the floor allowing a minimum of 36-inches of clearance from the rear of the rack to the rear wall except where otherwise expressly dimensioned on drawings.
 - d. Install rack doors and panels.
 - 2. Cabinet Types
 - a. Install bushings or grommets to protect cables where exiting or entering the rack. Clean, prep and paint visible conduits using oil-based paint that exactly matches color of equipment rack.
 - 3. Open Frame/Relay Types
 - a. Install bushings or grommets to protect cables where exiting or entering the rack. Clean, prep and paint visible conduits using oil-based paint that exactly matches color of equipment rack.
 - 4. Swinging Cabinet Types
 - a. Furnish and install minimum of two (2) 3-inch conduits stubs from top of cabinet back pan to cable tray, ladder rack and/or accessible ceiling above for cabling. Provide additional quantities and sizes as indicated on drawings. Install insulated throat bushings to protect cables. Clean, prep and paint visible conduits using oil-based paint that exactly matches color of equipment rack.
 - 5. Wall Mounted Types

- a. Furnish and install minimum of two (2) 3-inch conduits stubs from top of cabinet to cable tray, ladder rack and/or accessible ceiling above for cabling. Provide additional quantities and sizes as indicated on drawings. Install insulated throat bushings to protect cables. Clean, prep and paint visible conduits using oil-based paint that exactly matches color of equipment rack.
 - 6. Portable Types; Racks with Casters
 - a. Install insulated throat bushings to protect cables entering rack and other cable penetrations.
- B. Rack Accessories
- 1. Grounding Bus Bar
 - a. Install grounding bus bars in each equipment rack
 - 2. Filler Panels
 - a. Install the required size and type of filler panels in equipment racks.
 - b. The size, location and ratio of blank-to-vent filler panels shall be as required to assure proper ventilation of equipment.
 - c. Mount the filler panels within the rack using approved mounting hardware, ensuring that all unused spaces within the equipment rack are covered.
 - 3. Rack Lights
 - a. Supply and mount service lights in the rear of all equipment racks.
 - b. Where non-magnetic racks are supplied, supply and install Designer approved substitute fixture attachment hardware.
 - 4. Rack Drawers
 - a. Furnish and install rack drawers as indicated on the drawings.
 - 5. Ventilation Products
 - a. Furnish and install ventilation products as specified and indicated on the drawings. Test operation of all ventilation products and adjust as appropriate
 - 6. Cable Management Products

3.3 LABELING

- A. Label all equipment racks in accordance with Division 27 – “Identification for Communications”

END OF SECTION 27 11 16

SECTION 27 11 23

COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Supply and installation of complete and working cable management system(s) for use within communications rooms. Work includes, but is not necessarily limited to:
 - a. Specialty cable management and support products used to dress, support, store and organize cables mounted to walls and ceilings.
 - b. Horizontal and vertically oriented ladder rack used for support and management of cables.
 - c. Horizontal and vertical cable management used within equipment racks.

1.2 SYSTEM DESCRIPTION

- A. The cable management and ladder rack system shall accommodate the support and orderly routing and management of communications and related cabling with communication rooms.
- B. The system shall consist of horizontal ladder rack used for support of cables that need to traverse horizontally overhead within the room.
- C. The system shall consist of vertical ladder rack for support and dressing of cables that must traverse vertically from cable entry/exit points near the floor upwards towards the ceiling and/or to entry/exit points near the ceiling of the room.
- D. The system shall consist of horizontal and vertical cable management products used to support and dress cables that land on products mounted to the walls and/or ceilings.
- E. The system shall consist of horizontal and vertical cable management products used for management of communication cable products within an equipment rack

1.3 SUBMITTAL

- A. General
 - 1. Product data and shop drawing submittals for work of this section shall be submitted together as a single submittal.
- B. Product Data
 - 1. Bill of materials list
 - 2. Manufacture datasheets for all products and accessories

- C. Shop Drawings
 - 1. Communication room enlarged floor plan(s) depicting all of the following:
 - a. Sizes and locations of all ladder rack
 - b. Sizes and locations of other cable management products
 - c. Drawings shall be on 11x17 paper.
 - 2. Communication room(s) wall elevations depicting all of the following:
 - a. Sizes and locations of all ladder rack
 - b. Sizes and locations of other cable management products
 - c. Drawings shall be on 11x17 paper.
- D. Closeout Submittal
 - 1. Datasheets for all products used.
 - 2. Bill of materials list of products used in each communications room.
 - 3. Scaled and accurate as-built shop drawings.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Ladder Rack
 - 1. Horizontally mounted
 - a. Constructed of 1 ½ inch by 3/8 inch ASTM A513 compliant tubular steel
 - b. Black in color.
 - c. Dimensions shall be 12 to 24 inches wide (as indicated on the drawings) with 9 to 12 inch spacing between cable support rungs.
 - d. Horizontally installed ladder rack shall have 7-inch high posts spaced every two feet on center.
 - e. Basis of Design: Chatsworth 10250-712
 - f. Additional Approved Manufacturers: Homaco, PFT, B-Line/Saunders
 - 2. Vertically mounted
 - a. Constructed of 1 ½ inch by 3/8 inch ASTM A513 compliant tubular steel
 - b. White in color. (Matching white backboard)
 - c. Ladder rack dimensions shall be 12 to 24 inches wide (as indicated on the drawings) with 9 to 12 inch spacing between cable support rungs.
 - d. Basis of Design: Chatsworth 10250-212
 - e. Additional Approved Manufacturers: Homaco, PFT, B-Line/Saunders
 - 3. Spillways, Waterfalls, Cable Drop-outs
 - a. Basis of Design shall be Chatsworth 12100-xxx.
 - b. Additional approved manufacturers: Cooper/B-Line, Hoffman, Homaco, Middle Atlantic
- B. Voice/Data Rack Cable Management
 - 1. TYPE A (All Cable Management panels shall be of this type unless specifically noted as another type on the detail drawings).
 - a. Cable Management panels shall provide station cable routing on the rear and both horizontal and vertical metal slotted rings, and plastic wire holding clips on the front.
 - b. Basis of Design:
 - 1) 2 Rack Space units:

WIRE MGMT PANEL	WM-A(2RU)		
	Basis of Design	Additional Approved Product	Additional Approved Product
Manufacturer:	HOMACO	MIDDLE ATLANTIC	HUBBELL
H/W Inches:	3.5/19"	3.5/19"	3.5/19"
Panel	HFM-19-2	HCM-2DR	HC219GC36
Vert.Cable Mgmt Rings:	INCL	(2) D-RING	(2) HC23VR2
Front Cord Rings:	INCL	INCL	INCL
Rear Cable Chan- nel		INCL	INCL

2) 1 Rack Space units:

WIRE MGMT PANEL	WM-A(1RU)		
	Basis of Design	Additional Approved Product	Additional Approved Product
Manufacturer:	HOMACO	MIDDLE ATLANTIC	HUBBELL
H/W Inches:	1.75/19"	1.75/19"	1.75/19"
Panel	HFM-19-1SR	HCM-1DR	HC119GC36
Vert.Cable Mgmt Rings:	INCL	(2) D-RING	(2) HC23VR2
Front Cord Rings:	INCL	INCL	INCL
Rear Cable Channel	INCL	INCL	INCL

2. TYPE B (Shall be used when mounting in a Cabling Cabinet with Vertical Management installed)
 - a. Cable Management panels shall provide station cable routing on the rear and horizontal metal slotted rings, and plastic wire holding clips on the front.
 - b. Basis of Design:
 - 1) 2 Rack Space units:

WIRE MGMT PANEL	WM-B(2RU)		
	Standard of Quality	Additional Approved Product	Additional Approved Product
Manufacturer:	HOMACO	MIDDLE ATLANTIC	HUBBELL
H/W Inches:	3.5/19"	3.5/19"	3.5/19"
Panel	HFM-19-2SRC	HCM-2DR	HC219GC36
Vert.Cable Mgmt Rings:	NONE	NONE	NONE
Front Cord Rings:	INCL	INCL	INCL
Rear Cable Chan- nel	INCL	INCL	INCL

2) 1 Rack Space units:

WIRE MGMT PANEL	WM-B(1RU)		
	Standard of Quality	Additional Approved Product	Additional Approved Product
Manufacturer:	HOMACO	MIDDLE ATLANTIC	HUBBELL
H/W Inches:	1.75/19"	1.75/19"	1.75/19"
Panel	HFM-19-1SRC	HCM-1DR	HC119GC36
Vert.Cable Mgmt Rings:	NONE	NONE	NONE
Front Cord Rings:	INCL	INCL	INCL
Rear Cable Channel	INCL	INCL	INCL

C. Non-Voice/Data Rack Cable Management

1. Horizontal Cable Lacing Bars
2. Steel construction
3. Baked on enamel finish
 - a. Coordinate exact model(s) supplied with system supplier. Furnish LBR-1A when supplied rack is provided for future use.
4. Additional Approved Manufacturers: Atlas-Sound, Lowell Manufacturing
5. Quantity: Furnish (1) lacing bar for each 5-1/4" of vertical rack mounting space for each supplied equipment rack.

D. Vertical Cable Lacing Bars

1. Steel construction
2. Baked on enamel finish
3. 2-inch wide
4. Perforated design for easy mounting to rails within equipment racks and for securing cable tie wraps.
5. Basis of Design: Middle Atlantic LACE Series.
 - a. Coordinate exact models supplied with system supplier. Furnish LACE-P, sized to suit, when supplied rack is designated for future use.
6. Quantity: Furnish minimum (4) lacing bar for each equipment rack supplied.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ladder Rack

1. Within Communication Rooms
 - a. Within ER, TR, IDF, MDF communication rooms, ladder rack shall be installed to facilitate Cable Management within the space.
 - b. Where related drawings indicate specific routing, size and location of ladder rack, install ladder rack as indicated in these drawings.

- c. Where related drawings do not expressly depict ladder rack in communication rooms, supply and install ladder rack as follows:
 - 1) 12" horizontal ladder rack, minimum size, installed around the entire perimeter of the room. Install rack 12" below finished ceiling, but not less than 86" above finish floor. Install at a height that does not interfere with doors, windows and other equipment within the room.
 - 2) 12" horizontal ladder rack, minimum size, installed directly above and parallel to floor mounted equipment racks below. Ladder rack shall intersect and join the perimeter ladder rack.
 - 3) 12" vertical ladder rack, minimum size, installed on the wall at every floor and/or ceiling cable penetrations. Cable tray shall extend from the penetration to the perimeter cable tray.
 - 4) Furnish larger ladder rack sizes, as required, to accommodate all cables within the room.
 - 5) See "Horizontally Mounted" and "Vertically Mounted" installation guidelines for additional information.
- 2. Horizontally Mounted
 - a. Install ladder rack using manufacturer recommended hardware and accessories including, but not limited to: splice extension clamps; horizontal tee splice kits; corner support kits; adjustable vertical bend kits; adjustable vertical splice kits; runway support kits designed for ceiling
 - b. support from all threaded rod; runway drop-out at equipment racks; runway end caps; etc.
 - c. Install waterfall fittings in every location where cable is intended to exit the ladder rack downward, at the end of a run as well as between the rungs.
 - d. Support with threaded rod and U-channel supports systems.
 - e. Ladder rack shall be installed approximately 96" A.F.F, near the top of the backboards, unless otherwise noted on the drawings.
 - f. Rack mounted with a side along a backboard, may mount with wall brackets; utilize threaded rod and manufacturer's bracket kits for suspension of all remaining ladder rack sections.
 - g. Install as a complete system in accordance with manufacturer's written installation instructions as indicated on the Drawings and to ensure electrical continuity of the system and adequate support for the cabling. Provide all manufacturer's recommended fittings and accessories.
 - h. Provide support for the ladder rack at a minimum of 4' 6" on center and at all splices, tees, elbows, bends, intersections, and transitions.
 - 1) Support with threaded rod and U-channel supports systems
 - a) 12" width – 1/2" ATR; 24" width – 5/8" ATR
 - 2) Rod lengths over 6' will require a "Rod Stiffener" installation.
 - a) A section of U-Channel stock is placed around the rod and stiffener clamp assemblies used to clamp to rod
 - b) Place clamps a minimum of 6" from the top and bottom of the rod and every 18" in between.
 - i. Install the ladder rack system free of all sharp edges, burrs or projections that could harm cables or humans.
 - j. Provide side posts at 2' on center to both sides of the rack lengths.
 - k. Provide end caps as specified.
 - l. Install "waterfall" type protection for cable exit downward between rungs. l. Paint fittings as required to maintain aesthetic integrity of the installation.

- m. The ladder rack shall be ceiling supported with wall bracing at rack ends.
- 3. Vertically Mounted
 - a. Ladder rack rails shall mount flush against the backboard with rungs out.
 - b. Mount flat to backboard with wall mount clamps.
 - c. Rack mounted with one end on the floor and extending to intersecting cable tray/ladder rack used for horizontal cable delivery.
 - d. Install as a complete system in accordance with manufacturer's written installation instructions as indicated on the Drawings and to ensure electrical continuity of the system and adequate support for the cabling. Provide all manufacturer's recommended fittings and accessories.
 - e. Provide support for the ladder rack at a minimum of 3' on center up the entire length.
 - f. Install system free of all sharp edges, burrs or projections.
 - g. Ground and bond the system in accordance with the NEC and ANSI/TIA/EIA 607.
 - h. Provide end caps on all exposed ladder rack ends.
 - i. Trim out rectangular slot of appropriate size in ceilings, where applicable, to enable cable passage to above ceiling lines.
 - j. Paint fittings to maintain aesthetic integrity of the installation.
- 4. Spillways, Waterfalls, Cable Drop-outs
 - a. Shall mount securely to ladder rack rails and shall maintain minimum bend radius on all cables entering or exiting the ladder rack.
 - b. Install cabling exits a conduit sleeve, cable tray, or ladder rack and the cable(s) will be unsupported for more than six inches.
- B. Rack Mount Cable Management
 - 1. All cable management panels shall be securely attached with recommended screws.
 - 2. Install panels in positions indicated on related drawings.
 - 3. Perform final coordination with other specification systems prior to installation.

END OF SECTION 27 11 23

SECTION 27 11 26

COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Supply and installation of uninterruptible power supplies for communications equipment.
 - 2. Supply and installation of AC power distribution products for communications equipment.

1.2 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. Equipment racks, cabinets, frames and enclosures shall be provided with
- B. Uninterruptible Power Supplies (UPS) as indicated on the drawings.
- C. UPS shall be installed in all other locations as identified in this section and on the drawings.
- D. UPS shall supply power to equipment with the associated rack, cabinet, frame or enclosure in the event of any input power loss to the UPS.
- E. Power distribution systems shall be provided within all equipment racks, cabinets, frames and enclosures and shall be sufficient to deliver to all equipment contained within them.
- F. Power distribution products shall be provided on all communication backboards as indicated on the drawings and as additionally required to distribute power to all products mounted to the communications backboards.
- G. 20% minimum, unused spare AC power receptacles shall be provided in all equipment racks, cabinets, frames and enclosures. This spare capacity shall be remain for owner use after all specified and pre-designated future systems are installed.

1.3 SUBMITTALS

- A. Product Data
 - 1. Manufacture datasheets for all system equipment
 - 2. Complete BOM list
 - a. BOM shall include the following information for each product:
 - 1) Contractor's quantity estimates.

- 2) Manufacturer name.
- 3) Manufacturer model number (as it appears on manufacturer's product data sheet).
- 4) Manufacturer product description.
- 5) Paragraph number of this section where the product is specified.

B. Shop Drawings

1. Power Distribution Block Diagrams(s)
 - a. Drawings shall depict the specific power products and the exact AC power distribution configuration for each rack.
 - b. Separate power distribution diagrams shall be prepared and submitted for each rack, cabinet enclosure shall be presented on a separate drawing.
 - 1) Where identical power distribution arrangements are being planned to be supplied for multiple racks a typical shall be supplied that clearly identifies every rack (by Device ID) that will be using that specific power distribution plan.

C. Quality Assurance

1. RCDD Certification for the staff member responsible for this project.
2. Resume of the last 10 projects of the RCDD responsible for this project
3. BICSI Technician's certificate for each lead Technician(s) on the project

D. Closeout Submittal

1. Power Distribution Block Diagram(s)
 - a. Drawings shall depict the specific power products and the exact AC power distribution configuration for each rack

1.4 DELIVERY, STORAGE AND HANDLING

- A. Products of this section shall be furnished in timely manner to coordinate with work of other sections.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All AC power products furnished shall be UL Listed for the location and manner in which the product will be installed and used.
- B. All products furnished of a given type under this section shall be manufactured by a single manufacturer; shall bear the same brand name; shall be of the same finish color and texture; and shall be from the same product model series unless otherwise noted and/or approved by the Designer.

2.2 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

- A. General

1. Unless otherwise noted on the drawings, all UPS units shall be manufacturer designed for rack mounting and shall be furnished with all mounting hardware.

B. 2kVA Size

1. True on-line double conversion.
2. Furnished with power management software.
3. 120VAC input and output.
4. 19" EIA rack mounting hardware
5. NEMA 5-20 plug
6. Four (4) NEMA 5-20 receptacles
7. Basis of Design: Liebert GXT5 Series
8. Additional approved manufacturer(s): APC

C. 3kVA Size

1. True on-line double conversion.
2. Furnish with power management software.
3. 208VAC input and output.
4. 19" EIA rack mounting hardware
5. NEMA L6-30 plug
6. 4 NEMA 5-15R Receptacles
7. One NEMA L5-30R Receptacle
8. Basis of Design: Liebert GXT5 Series
9. Additional approved manufacturer(s): APC

2.3 POWER DISTRIBUTION

A. General

1. Furnish receptacles of the amperage rating matching the power feed(s) to the rack.

B. Within Voice/Data Equipment Racks

1. 15A Vertical multi-outlet power strips (Use with 3KVA RM UPS)
 - a. 120VAC input
 - b. NEMA 5-15R receptacles (14 – 24 outlets)
 - c. 45 - 72 inch length
 - d. 9 foot power cord with Nema5-15P plug
 - e. Basis of Design: Middle Atlantic PDT-1415C-NS and PB-5A brackets.
 - f. Additional approved manufacturers:
 - 1) Great Lakes Case & Cabinet #7215
 - 2) Hoffman # DP1N622415
2. 20A Vertical multi-outlet power strips (Use with 2KVA RM UPS or Floor Model and Power Distribution Panel within room.)
 - a. 120VAC input
 - b. NEMA 5-20R receptacles (14 - 24 outlets)
 - c. 49 - 72 inch length
 - d. 9 foot power cord with NEMA 5-20P plug
 - e. Basis of Design: Middle Atlantic PDT-1220C-NS and PB-5A brackets.
 - f. Additional approved manufacturers:
 - 1) Great Lakes Case & Cabinet #7215-20AR
 - 2) Hoffman # DP1N622420

C. Within Sound Reinforcement and Audio-Video Systems equipment racks

1. General

- a. Each rack shall be furnished with a complete and working AC power distribution system.
- b. System shall consist of a remotely controllable power sequencer and AC power outlets controlled by this sequencer.
- c. Refer to both Communication Technology and Electrical series drawings to determine the presence of isolated-ground circuits feeding the equipment rack(s). Provide isolated ground versions of power distribution products as required to match power supplied.
- d. Where rack is designated for future use and where no system is specified for the rack, furnish (2) discrete vertical receptacle strips, each strip containing at least one (1) AC receptacle for every 5-1/4" inches of rack mounting space within the equipment rack.

2. Integrated Power Sequencing System

- a. Equipment racks with fewer than 12 products requiring AC power, and less than 12 amperes of continuous current draw shall be provided with an integrated power sequencing system plus supplemental power strips. This system shall consist of.
 - 1) Rack mounted power sequencer with integral AC receptacles
 - 2) Supplemental Vertical AC power strips.
- b. Rack Mounted Power Sequencer
 - 1) Rack Mounted
 - 2) Front panel power switch
 - 3) Low-voltage remote control input
 - 4) Low-voltage status output port
 - 5) 120VAC Input
 - 6) (6) Nema5-15R Duplex Receptacles
 - 7) Nema5-15P Input plug
 - 8) 15 amp current rating
 - 9) Basis of Design: Middle Atlantic PDS-615R
- c. Vertical Power Strips
 - 1) Furnish quantity of individual strips containing the quantity of receptacles required (plus 20% spares) to fit within the supplied equipment rack(s).
 - 2) Basis of Design: Middle-Atlantic PD-Series

3. Modular Power Sequencing System

- a. Equipment racks with greater than 12 products requiring AC power or a continuous current draw of 12 amperes or more shall be furnished with a complete and working modular power sequencing system consisting of:
 - 1) Power Sequence controller
 - 2) 6-circuit capable, 6-duplex outlet modular power distribution strips.
 - 3) Supplemental vertical power strips adequate AC receptacles to accommodate all equipment in the equipment rack (plus 20% spare capacity).
- b. Power Sequence Controller
 - 1) Six (6) low voltage control outputs
 - 2) External remote control inputs
 - 3) Status output ports
 - 4) 19" EIA rack mountable
 - 5) 1 Rack unit high

- 6) Front panel power switch and status LEDs
- 7) Basis of Design: Middle-Atlantic USC-6R Universal Sequence
- 8) Controller
- 9) Additional approved manufacturers: Brand/Model specific pre-approval required.
- c. Modular Vertical Raceway System
 - 1) Raceway
 - a) 3-Module Modular Raceway
 - (A) Overall Length: 32 inches
 - (B) Basis of Design: Middle-Atlantic MPR-3
 - b) 6-Module Modular Raceway
 - (A) Overall Length: 56 inches
 - (B) Basis of Design: Middle-Atlantic MPR-6
 - c) 9-Module Modular Raceway
 - (A) Overall Length: 80 inches
 - (B) Basis of Design: Middle-Atlantic MPR-9
 - 2) Power Modules
 - a) 20Amp – 120volt – Remote Controllable
 - (A) Nema5-20R Duplex Receptacle
 - (B) Basis of Design: Middle-Atlantic RM-20
 - b) 20Amp – 120volt – Remote Controllable – Isolated Ground
 - (A) Nema5-20R(IG) Duplex Receptacle
 - (B) Basis of Design: Middle-Atlantic RM-20IG
 - c) 15Amp – 120volt – Remote Controllable
 - (A) Nema5-15R Duplex Receptacle
 - (B) Basis of Design: Middle-Atlantic RM-15
 - d) 15Amp – 120volt – Remote Controllable – Isolated Ground
 - (A) Nema5-15R(IG) Duplex Receptacle
 - (B) Basis of Design: Middle-Atlantic RM-15IG
 - e) Blank Modules
 - (A) Basis of Design: Middle-Atlantic MPR-BL
 - 3) Jumper Cables
 - a) Receptacle to receptacle power jumpers
 - b) 12, 24 and 72 inch length available
 - c) Connectorized at both ends to mate with receptacles
 - d) Basis of Design: Middle-Atlantic J series
 - e) Tail Cables
 - f) Basis of Design: Middle-Atlantic T series
4. Vertical Power Strips
 - a. Basis of Design: Middle-Atlantic PD-Series
 - b. Furnish quantity of individual strips containing the quantity of receptacles required (plus spares) to fit within the supplied equipment rack(s).
- D. Within Public Address, Intercom, and Security System(s) Equipment Racks
 1. General
 - a. Each rack shall be furnished with a complete and working internal power distribution system consisting of enough AC receptacles to accommodate all equipment to be housed within the equipment rack, plus a 20 percent spare outlet capacity.
 - b. Refer to both Communication Technology and Electrical drawings to determine the presence of isolated-ground circuits feeding the equipment

- rack(s). Furnish isolated ground versions of power distribution products to match incoming power feed(s).
 - c. Where rack is designated for future use and where no system is specified for the rack, furnish (2) discrete vertical receptacle strips, each strip containing at least one (1) AC receptacle for every 5-1/4" inches of rack mounting space within the associated equipment rack.
 - 2. Vertical Rack Power Strips
 - a. Full Rack Length
 - b. 120VAC operating voltage
 - c. 20-Amp and 15-Amp capacity versions
 - d. Standard and Isolated Ground versions
 - e. Basis of Design: Middle Atlantic PD Series
 - f. Additional Approved Manufacturers: Wiremold, Hammond
 - g. Manufacturing, Tripplite
 - 3. Rack Mount Receptacle Strips
 - a. 20 Amp – Non-Isolated Ground Version
 - 1) 19" EIA Rack Mountable
 - 2) 1-3/4" High
 - 3) 20Amp Nema5-20P Plug
 - 4) 6' AC Power Cord
 - 5) Integral 20Amp Circuit Breaker
 - 6) Front Panel AC power switch
 - 7) No front panel receptacles
 - 8) Minimum of 6 rear-mounted Nema5-20R receptacles
 - 9) Basis of Design: Hammond Manufacturing 1589H6F1BKRR
 - b. 15Amp – Non-Isolated Ground Version
 - 1) 19" EIA Rack Mountable
 - 2) 1-3/4" High
 - 3) 15Amp Nema5-15P Plug
 - 4) Receptacles rotated 90 degrees (i.e. perpendicular) to length receptacle strip
 - 5) 6' AC Power Cord
 - 6) Integral 15Amp Circuit Breaker
 - 7) Front Panel AC power switch
 - 8) No front panel receptacles
 - 9) Minimum of 6 rear-mounted Nema5-15R receptacles
 - 10) Basis of Design: Hammond Manufacturing 1583H6A1BKRA
- E. Within all Other Equipment Racks
- 1. Unless otherwise specified herein and/or shown and/or noted on the related drawings each supplied rack shall be provided, minimally, with the following:
 - a. One (2) 15-Amp 120VAC Single-circuit vertical power receptacle strips.
 - b. Receptacle strip shall contain at least (1) Nema5-15R AC power outlet for each 3-1/2" of vertical rack mounting space. For example: A 44-rack unit cabinet shall have at least 22 total AC outlets.
 - c. One (1) 20Amp 120VAC Single-circuit horizontal AC rack-mount AC power receptacle strip. Receptacle strip shall contain (6) Nema5-20R AC power outlets.

PART 3 - EXECUTION

3.1 COORDINATION

- A. This Contractor shall coordinate with all other Contractors and sub-contractor(s) supplying and installing equipment racks, cabinets, frames and enclosures as well as the contractors providing

3.2 INSTALLATION

- A. General
 - 1. Secure all fixed position equipment racks using removable threaded fasteners to prevent equipment racks from movement and tipping over.
- B. Uninterruptible Power Supplies and Power Distribution
 - 1. General
 - a. Coordinate directly with each system/equipment supplier/contractor/sub-contractor prior to installation of UPS, sequential controllers and receptacle strips to coordinate the installed location of these products. Location of these products shall complement the location of all connected products.
 - 2. Uninterruptible Power Supplies (UPS)
 - a. Plug UPS into un-switched AC power source.
 - b. Rack-mount both the power supply(s) and their accessory batteries as applicable.
 - 3. Telecommunication Racks
 - a. Mount receptacle strips vertically in the rear of a cabinet or on rear of open frame relay racks.
 - b. When UPS products are present, connect receptacle strips into outlets located on the UPS.

3.3 POWER DISTRIBUTION DEVICES:

- A. Provide specified plug-in outlet centers in each equipment rack or backboard.
 - 1. Plug-in outlet centers shall be securely mounted to the equipment rack utilizing
 - 2. Manufacturer's recommended hardware.
 - 3. Position to allow the Owner adequate access and avoid functionality conflicts with rack features (i.e. adjustable rails).

END OF SECTION 27 11 26

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SECTION 27 13 23

COMMUNICATIONS FIBER OPTIC BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Supply and installation of a complete and working Fiber Optic Backbone Cabling Systems for
 - 1. Multi-Purpose Fiber Optic Backbone
 - a. Including Data connectivity provisions for Data Network and Other Systems (i.e. Video Surveillance, Access Control, Control Data, Intrusion Detection, etc.).
 - 2. System includes but is not limited to:
 - a. Backbone cabling.
 - b. Connectors
 - c. Patch panels

1.2 REFERENCES

- A. ANSI/TIA/EIA-568-B – Commercial Building Telecommunications Cabling Standard.
- B. ANSI/TIA/EIA-569-A – Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. ANSI/TIA/EIA-606 – The Administrative Standard for the Telecommunications Infrastructure of Commercial Building.
- D. ANSI/TIA/EIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.
- E. ANSI/TIA/EIA 568 B.1 (SP-4425) General Cabling Systems Requirements
- F. ANSI/TIA/EIA 568 B.3 (PN-3894) Optical Fiber Cabling Systems.
- G. “TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL” published by the Building Industry Consulting Services International (BICSI).

1.3 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. The system shall be a multi-strand Fiber Optic backbone cabling system
 - 1. Provide, test, and label all cables and terminations devices as described below and as shown on the plans.
 - 2. The system shall be an ANSI/TIA/EIA 568-B compliant Fiber Optic backbone cabling system.

3. See related Drawings for specific Project requirements.
4. The system shall consist of total connectivity for a complete and permanent installed communications link.
5. Refer to Backbone Diagram for types, quantities of cables.
6. Refer to detail drawings for terminations standards and positioning of termination devices.
7. Refer to floor plans for termination locations.
8. All cables shall be continuous without splices and shall be of proper construction for the designated use.
9. All system cables shall be UL/NEC rated for the location, manner and site conditions in which the cables are installed. This includes, but is not limited to:
 - a. Use of the cable rated for the application
 - b. Not exceeding fill capacities of raceways
 - c. All cable used shall be in compliance with Local, State, and Federal laws (at minimum the NFPA published "National Electric Code") as to acceptability for placement in the designed pathway. This includes, but is not limited to, cable fill capacities of raceways and plenum vs. non-plenum construction. The Contractor shall provide and install the appropriate cable for the appropriate conditions.
 - d. Fiber Optic Backbone (Multi-purpose)

1.4 QUALITY ASSURANCE

- A. The Prime Contractor or his subcontractor responsible for this Section shall have a Registered Communications Distribution Designer (RCDD) on staff that will be ultimately responsible for this Project. The RCDD must have sufficient experience in this type project as to be able to lend adequate technical support to the field forces during installation, the warranty period, and any extended warranty periods or maintenance contracts. If in the opinion of the Owner, the RCDD does not possess adequate qualifications to support the Project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner's opinion, possesses the necessary skills and experience required of this Project.
- B. The lead technician(s) on the Project shall carry a current BICSI Technician Certificate or have five years of experience in projects of similar scope.
- C. The lead technician(s) on the Project shall have a thorough understanding of the following:
 1. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 568B Commercial Building Telecommunications Cabling Standard.
 2. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and spaces.
 3. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA/EIA 606 The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
 4. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

- D. All Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation practices.

1.5 SUBMITTALS

A. General

- 1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.
- 2. Samples shall be submitted with or immediately following submission of Product Data submittals.

B. Product Data

- 1. Manufacture datasheets for all system equipment
- 2. Manufacture datasheets for all cable
- 3. Manufacture datasheets for all connectors
- 4. Complete BOM list
 - a. BOM shall include the following information for each product:
 - 1) Contractor's quantity estimates
 - 2) Manufacturer name
 - 3) Manufacturer model number (as it appears on manufacturer's product data sheet)
 - 4) Manufacturer product description
 - 5) Paragraph in this section where product is specified.

C. Shop Drawings

- 1. Plan Drawing(s)
 - a. Depicting the location of all drops and major equipment locations at the project site, coordinate with work of related sections.
- 2. System Riser Diagram(s).
 - a. Depicting the interconnecting cabling between system equipment located at different locations at the project site.
- 3. System block wiring diagram, detailed.

D. Quality Assurance / Control Submittals

- 1. RCDD Certification for the staff member responsible for this project.
- 2. Resume of the last 10 projects of the RCDD responsible for this project
- 3. BICSI Technician's certificate for each lead Technician(s) on the project

E. Closeout Submittal

- 1. Backbone diagram indicating all backbone cables and the connectivity provided; i.e. show cable types and the to-and-from locations for each.
- 2. Equipment Room/Telecommunications Room rack/cabinet layouts (to scale) showing rack space used by each installed component.
- 3. A diagram of the labeling scheme used on the Project.
- 4. Cable manufacturer's certification of quality and performance.
- 5. Extended Warranty Certificate.

1.6 WARRANTY

- A. Additional requirements: All cabling and connectivity products manufacturers, including patch cords, shall have in place an agreement recognizing each other for complete execution of warranty as specified. All performance and applications warranties shall be channel rated.
 - 1. The cable manufacturer and the connectivity products manufacturer shall have a partnership agreement established in order to provide the required warranty.
 - 2. Required warranty:

PART 2 - PRODUCTS

2.1 PRODUCT STANDARDS

- A. General
 - 1. This section is designed to provide the Contractor with a minimum Basis of Design and functionality for the products used for telecommunications infrastructure.
 - 2. This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.
 - 3. Products required by the Drawings but not enumerated will be evaluated as a performance specification based on the information provided on the Drawings.

2.2 CABLES

- A. General
 - 1. All cables on this Project shall be color-coded. Refer to Division 27 Section "Identification for Communications".
 - 2. OFNP and OFNR references below are as required by the NEC published by the
 - 3. National Fire Protection Association.
 - a. Cables not specifically identified otherwise, shall be provided with CMP classification.
 - b. Exceptions:
 - 1) Requirements for Outside Plant Rated cables.
 - 2) Cables run in continuous conduit.
 - 3) Proper cable classification is ultimately determined by building construction; reductions in classification for cables, not clarified or altered by addendum to the specifications, will require a deduct in price through a change order.
 - 4. All references below for pathways, conduits, etc. are as defined by Division 27 Section "Pathways for Communications".
- B. Fiber Optic Cables:
 - 1. General
 - a. Where Multimode and Singlemode fiber optic cable requirements share the same start point, the same end point, and the same pathway, hybrid cables may be used to combine the Multimode and Singlemode strands under a common jacket.
 - b. All indoor fiber optic cable shall be of interlocking armored construction.

- 1) Any fiber optic cable not of interlocking armored construction shall be installed in a properly rated (plenum) inner-duct as specified in related Division 27 Section "Pathways for Communications".
2. Optical Requirements:
 - a. All Multimode fiber optic cable is required to have the following optical characteristics:
 - 1) Optimized multi-mode fiber cable shall be 50/125 micron diameter with dual window of 850/1300 nm with industry standard color coding.
 - 2) Cable shall meet or exceed ISO/IEC 11801 OM4 Grade 6 optical characteristics.
 - 3) Optical characteristics shall include minimum Modal Bandwidth of
 - 4) 4700 MHz/km (EMB) at 850nm and 500 MHz/km at 1300nm allowing guaranteed GigaBit Ethernet distances of 1000 m at 850 nm and 550 m at 1300 nm with guaranteed 10 Gigabit Ethernet distances of 550 m at 850nm and 300 m at 1300 nm.
 - 5) Maximum attenuation – (dB/km) 3.5 at 850 nm and 1.5 at 1300 nm.
 - b. All Singlemode fiber optic cable is required to have the following optical characteristics:
 - 1) Singlemode fiber cable shall be 8.3/125 micron diameter with dual window of 1310/1550 nm with industry standard color coding. Cable shall meet TIA/EIA 492-CAAA.
 - a) Maximum attenuation – (dB/km) .7 @ 1310 nm and .7 @ 1550 nm.
3. Construction
 - a. Cable shall be of all-dielectric construction unless specifically noted otherwise.
 - b. All fiber optic cable will be properly constructed for the environmental conditions and to meet all applicable codes.
 - c. The following basic construction types are recognized on this Project:
 - 1) Tight buffer armored premise distribution cable
 - 2) Plenum (OFNP) rated construction unless otherwise specifically noted.
 - 3) Used in indoor pathways primarily as backbone cable.
 - 4) Fiber counts can range from 4 to 72 strands
 - 5) Hybrid SM/MM strand mix is acceptable.
 - 6) This cable construction will never be used in an outdoor or harsh environment.
 - 7) Multimode Basis of Design shall be as manufactured by
 - 8) General Cable BL024IPNU-ILP(A) (MM 24 STRAND)
 - 9) Singlemode Basis of Design shall be as manufactured by General Cable AP006IPNU-ILPA (SM 6 STRAND) (Confirm Color and Strand Count)
 - 10) Additional approved manufacturers: Berk-Tek, Mohawk, Corning.

2.3 TERMINATION HARDWARE

A. General

1. Suggested layout of termination hardware is indicated on the Drawings. Coordinate layout of termination hardware with the Owner's Representative or Consultant/Architect/Engineer before installation.
 2. The manufacturer of the cable and the manufacturer of the connectivity products shall have a partnership agreement established in order to provide the required warranty. See Warranty requirements above and in related Section 27 00 01.00.
 3. All devices shall be UL listed as required by the NEC published by the National Fire Protection Association.
- B. Equipment/Telecommunications Room Cabinet/Rack
1. The following basic termination devices are available and recognized for this Project.
 - a. Fiber Optic Patch Panel 24 port
 - 1) Panel shall be black steel with smoked Plexiglas door
 - 2) Rear tray capacity for optional splice trays
 - 3) Slack management spools included
 - 4) Drawers slide out for easy front access
 - 5) Accepts standard 6-pack assemblies; 4 units (FAP or FMP)
 - 6) Mountable in 1 rack space (1.75") EIA standard 19" rack/cabinet rails.
 - 7) Must use F/O Coupler Packs; see below
 - 8) Basis of Design shall be Panduit FMD1
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - b. Fiber Optic Patch Panel 48 port
 - 1) Panel shall be black steel with smoked Plexiglas door
 - 2) Rear tray capacity for optional splice trays
 - 3) Slack management spools included
 - 4) Drawers slide out for easy front access
 - 5) Accepts standard 6-pack assemblies; 8 units (FAP or FMP)
 - 6) Mountable in 2 rack spaces (3.50") EIA standard 19" rack/cabinet rails.
 - 7) Must use F/O Coupler Packs; see below
 - 8) Basis of Design shall be Panduit FMD2
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - c. Fiber Optic Coupler Packs - Multimode
 - 1) Panel shall be black steel individual couplers installed
 - 2) Mounts in 24 or 48 port Fiber Optic patch panel
 - 3) 6 duplex LC adapters with phosphor bronze sleeves (MM)
 - 4) Color code MM couplers Aqua
 - 5) Basis of Design shall be Panduit FAP6WAQDSC
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - d. Fiber Optic Coupler Packs - Singlemode
 - 1) Panel shall be black steel individual couplers installed
 - 2) Mounts in 24 or 48 port Fiber Optic patch panel
 - 3) 6 simplex LC adapters with ceramic sleeves (SM)
 - 4) Color code SM couplers Blue; utilize industry standard color coding
 - 5) Basis of Design shall be Panduit FAP6WBUSCZ
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics

C. Wall-mounted Termination

1. The following basic termination devices are available and recognized for this Project.
 - a. Wall Mounted Fiber Optic Patch Panel 24 port
 - 1) Panel shall be black steel with dual doors and locks
 - 2) Tray capacity for optional splice trays
 - 3) Slack management spools included
 - 4) Accepts standard 6-pack assemblies; 4 units (FAP or FMP)
 - 5) Wall Mountable; 13" x 16" x 5"
 - 6) Must use F/O Coupler Packs; see below
 - 7) Basis of Design shall be Panduit FWME4
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - b. Fiber Optic Coupler Packs - Multimode
 - 1) Panel shall be black steel individual couplers installed
 - 2) Mounts in 24 or 48 port Fiber Optic patch panel
 - 3) 6 duplex LC adapters with phosphor bronze sleeves (MM)
 - 4) Provide adapter plate with couplers to match specified fiber performance. Utilize industry standard color coding.
 - 5) Basis of Design shall be Panduit
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics
 - c. Fiber Optic Coupler Packs - Singlemode
 - 1) Panel shall be black steel individual couplers installed
 - 2) Mounts in 24 or 48 port Fiber Optic patch panel
 - 3) 6 simplex LC adapters with ceramic sleeves (SM)
 - 4) Provide adapter plate with couplers to match specified fiber performance.
 - a) Color code SM couplers Blue; utilize industry standard color coding
 - 5) Basis of Design shall be Panduit
 - a) Additional approved manufacturers: Hubbell, Leviton, Ortronics

D. Discrete Cable Connectors

1. The following basic termination devices are available and recognized on this Project:
 - a. LC Connector Multi-mode
 - 1) Provide connector to match specified fiber performance; utilize industry standard color coding.
 - 2) Each connector shall use a U/V or adhesive/epoxy to firmly adhere the glass strand to the connector.
 - 3) The connector ferrule shall be ceramic.
 - 4) The connector must provide 0.10dB typical attenuation or less
 - 5) Provide duplex LC clip, as required
Standard of quality shall be Panduit. Additional approved manufacturers: 3M, Leviton, Ortronics, or Hubbell.
 - b. LC Connector Single-mode
 - 1) Provide connector to match specified fiber performance; utilize industry standard color coding.

- 2) Each connector will use a U/V or adhesive/epoxy to firmly adhere the glass strand to the connector.
- 3) The connector ferrule shall be ceramic.
- 4) The connector must provide 0.15dB typical attenuation or less
- 5) Provide duplex LC clip, as required
- 6) Standard of quality shall be Panduit. Additional approved manufacturers: 3M, Leviton, Ortronics, or Hubbell
- c. Fiber Optic Break-out (fan-out)/(furcation) kit.
 - 1) Shall be used for all fiber optic cable terminations
 - 2) Shall include buffer tubing and heat shrink tubing for each strand to have an 18" length from break-out.
 - 3) Basis of Design shall be Corning cable Systems FAN-BT25-xx (Indoor) or FAN-OD25-xx (Outdoor)
 - 4) Additional approved manufacturer(s): Hubbell, Leviton, Ortronics Panduit

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. This section is designed to provide a Basis of Design and functionality for the installation of technology systems infrastructure. Not all procedures will be necessary for the installation of this Project; however, this standard shall be considered in force for the original response as well as for any additions or changes to this Project.

3.2 INSTALLATION

- A. Coordination
 1. Review and coordinate proper pathways prior to installation.
 2. Reference the TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL (TDMM) published by the Building Industry Consulting Services International (BICSI) for cable installation practices. This Specification may take exception to optional statements within the TDMM. Treat any conflict per this Specification under discrepancies or Conflicts.
- B. General
 1. Cable routing shall follow building structure lines and shall be installed with adequate length to reach to any location within the equipment racks with at least 5 feet of service loop at each end.
 2. At point of final terminations, excess cable and the service loop shall be stored and dressed neatly.
 - a. At the station end of the cable the service loop shall be stored above the ceiling line at an accessible point and supported with an approved device designed for that purpose.
 - b. Within a communications room the service loop shall be dressed and stored within the ladder rack.

3. Provide strain relief at all connection points. Strain relief techniques shall be applied to all cables to lessen the risk of physical cable damage and to provide proper aesthetic value.
4. Route all cabling and pathways parallel to building surfaces and at 90 degree angles to the building structure.
5. Cable runs shall be continuous and without splices.
6. Wiring shall be free from grounds, shorts, opens, and reversals.

C. Protection:

1. Maintain protection of all cabling throughout the entire duration of the project.
2. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other contractors or trades. Cabling shall be bundled, supported, and protected up out of the way of other trades any time it is determined necessary to ensure the safety of personnel or protection of the cable.
3. Do not terminate cables designated for different services onto the same patch panel unless otherwise clearly indicated on the drawings.
4. Do not exceed minimum bend radius or pulling tension specifications set forth by the product manufacturer.
5. Cable Separation and Organization
 - a. Cables of different services shall not be intertwined.
 - b. Cables of all service types shall be organized and kept segregated within cable trays, ladder rack, wire management and other pathways.
 - c. Terminate all cabling on specified termination hardware in numerical order and on specified outlets.

D. Labeling

1. Every cable shall have a label applied to the jacket at each end.
2. Each terminating device and port shall have a unique identifier.
3. Label all cabling and terminations as specified and indicated on related drawings.

E. Raceways

1. Install cabling within conduit or in surface raceway where specified in this or related sections or as indicated on the drawings.
 - a. Surface raceway is permissible for use only where expressly indicated on the drawings.
2. Cabling shall be installed in a concealed manner. Cables may be visible only in the following areas. (Provide concealed rough-ins for all device and outlet locations.)
 - a. Equipment Rooms
 - b. Telecommunications Rooms
 - c. Building spaces equipped with cable trays but without finished ceilings to conceal the cables.
3. Install cabling in cable tray and ladder rack where specified in this or related sections or as indicated on the drawings.
4. Support cables using approved products and methods whenever conduit, surface raceway or cable tray are not specified. Cable supports shall be attached directly to building structure.
5. Entry/exit from raceways shall be made in a uniform and consistent manner and shall not exceed the minimum bend radius of the cable.

6. Route all cabling and pathways parallel or at 90 degree angles to the structure.
 7. Support cabling with the appropriate cable supports and from the building structure.
- F. Wall and Floor Penetrations
1. Provide conduit sleeves with bushings on each end for all cabling penetrations. Split bushings shall not be permitted. Patch and firestop around the sleeve. Firestop the interior of the sleeve after cable is installed.
 2. Firestop all firewall penetrations to return the wall to its original rating. Outlet boxes installed in firewalls shall be similarly firestopped.
- G. Cable Supports
1. Neatly dress, support and securely attach all cabling on backboards and in equipment racks.
 2. Where cabling is not supported by cable tray or conduit, provide necessary cable support as specified. Provide nylon cable tie at the support to contain cabling within the support. Do not bundle cable between supports. Provide cable support as specified at intervals not to exceed 5 feet. Do not secure cabling to the support. Do not use cable supports with round surfaces (i.e. bridal rings).
 3. Route all cabling and pathways parallel or at 90 degree angles to the structure. Support cabling with the appropriate cable supports and from the building structure.
- H. Termination
1. Terminate each end of every cable per the manufacturer's printed instructions.
 2. Terminate each cable in numerical order on adjacent ports on the specified termination hardware within the appropriate communications room.
 3. Terminate cables using the tools and connectors specified and as recommended by the cable/connector manufacturers' printed instructions.
- I. Separation from Sources of Interference
1. Route cables at least 1.2m (4 foot) from motors or transformers; 30 cm (1 foot) from conduit and cables used for AC power distribution; 12 cm (5 inches) from fluorescent lighting fixtures.
- J. Backbone cabling:
1. Multimode and singlemode fiber optic cabling shall be terminated with fusion-spliced, factory polished pigtails.
 2. Provide service loop as specified or a minimum of 5 feet at each end and 10 feet at each junction point.
 3. Do not violate the minimum bend radius specified by the manufacturer of the cable.
 4. Provide buffer tubing on all fiber strands from the connector to the cable break-out (minimum 6 inch pigtails) and secure to the cable jacket for all fiber optic cables that do not have a cladding.
 5. Route intra-building backbone cabling through primary pathways between
 6. Equipment Rooms/Telecommunications Rooms.

3.3 TESTING

- A. All cables shall be fully tested and verified compliant with these specifications. All fiber optic cables shall be tested with both a power meter and an OTDR with results stored and submitted in both hard copy and electronic format for review.
 - 1. See Division 27 - Verification Testing of Structured Cabling for additional fiber optic backbone performance testing parameters and procedures.
- B. The Owner reserves the right to have a representative present during any or all testing procedures. Verification testing of copper and fiber may be performed at or near Project completion by the Consultant for quality assurance.
- C. Upon verification testing, if the Consultant finds the test results do not match the Contractor's results, the Consultant or a third party may at the Owner's request retest all of the cabling and submit those results to the Owner and deduct the verification testing costs from the Contractor's Contract amount.

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SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Supply and installation of a complete and working Horizontal Cabling Systems for
 - a. Voice / Telephone
 - b. Data / Network
 - 1) Including Data provisions for Other Systems (i.e. Video Surveillance, Access Control, Control Data, Intrusion Detection, etc.).
 - 2. System includes but is not limited to:
 - a. Horizontal cabling.
 - b. Station outlets including frames, connector modules, and cover plates.
 - c. Patch panels

1.2 REFERENCES

- A. ANSI/TIA/EIA-568-B.1 – Commercial Building Telecommunications Cabling Standard.
- B. ANSI/TIA/EIA-569-A – Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. ANSI/TIA/EIA-606 – The Administrative Standard for the Telecommunications Infrastructure of Commercial Building.
- D. ANSI/TIA/EIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.
- E. ANSI/TIA/EIA 568 B.1 (SP-4425) General Cabling Systems Requirements
- F. ANSI/TIA/EIA 568-B.2 (PN-4426) 100 Ohm Twisted Pair Copper Cabling Systems
- G. “TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL” published by the Building Industry Consulting Services International (BICSI).

1.3 SYSTEM DESCRIPTION / DESCRIPTION OF WORK

- A. The system shall be a 4 pair UTP copper Horizontal cabling system.
 - 1. Provide, test, and label all cables and terminations devices as described below and as shown on the plans.

2. The system shall be an ANSI/TIA/EIA 568-B compliant Unshielded Twisted Pair (UTP) horizontal cabling system.
3. The Horizontal voice cabling systems shall be Category 6 compliant system.
4. The Horizontal data cabling system shall be Category 6 compliant system.
5. See related Drawings for specific Project requirements.
6. The system shall consist of total connectivity for a complete and permanent installed communications link.
7. Refer to detail drawings for terminations standards and positioning of termination devices Provide, test, and label all cables and terminations devices as described below and as shown on the plans.
8. The cable distance between the termination point with a Communications Room(s) and the station outlet(s) shall be no greater than 90 meters (300 ft).
9. The total channel distance shall not exceed 100 meters (328 feet) distance between equipment in the Communications room and station equipment, including all patch cables and station attachment cables
10. All system cables shall be continuous between points of termination, without splices.
11. All system cables shall be UL/NEC rated for the location, manner and site conditions in which the cables are installed. This includes, but is not limited to:
 - a. Use of the cable rated for the application
 - b. Not exceeding fill capacities of raceways
 - c. All cable used shall be in compliance with Local, State, and Federal laws (at minimum the NFPA published "National Electric Code") as to acceptability for placement in the designed pathway. This includes, but is not limited to, cable fill capacities of raceways and plenum vs. non-plenum construction. The Contractor shall provide and install the appropriate cable for the appropriate conditions.

1.4 QUALITY ASSURANCE

- A. The Prime Contractor or his subcontractor responsible for this Section shall have a Registered Communications Distribution Designer (RCDD) on staff that will be ultimately responsible for this Project. The RCDD must have sufficient experience in this type project as to be able to lend adequate technical support to the field forces during installation, the warranty period, and any extended warranty periods or maintenance contracts. If in the opinion of the Owner, the RCDD does not possess adequate qualifications to support the Project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner's opinion, possesses the necessary skills and experience required of this Project.
- B. The lead technician(s) on the Project shall carry a current BICSI Technician Certificate or have five years of experience in projects of similar scope.
- C. The lead technician(s) on the Project shall have a thorough understanding of the following:
 1. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 568B Commercial Building Telecommunications Cabling Standard.

2. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and spaces.
 3. American National Standards Institute/Telecommunications Industry Association – ANSI/TIA/EIA 606 The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
 4. American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association – ANSI/TIA/EIA 607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
- D. All Work shall fully comply with these specifications and related Drawings and all manufacturers recommended installation practices.

1.5 SUBMITTALS

- A. General
1. Product Data and Shop Drawing submittals for work of this section shall be SUBMITTED TOGETHER, complete, as a single submittal. Product Data and Shop Drawings are not to be submitted separately.
 2. Samples shall be submitted with or immediately following submission of Product Data submittals.
- B. Product Data
1. Manufacture datasheets for all system equipment
 2. Manufacture datasheets for all cable
 3. Manufacture datasheets for all connectors
 4. Complete BOM list
 - a. BOM shall include the following information for each product:
 - 1) Contractor's quantity estimates
 - a) Submission/acceptance of this estimate does in no way relieve the Contractor of the responsibility to provide the materials as required to fulfill all work as specified and as shown on the Drawings.
 - b) Manufacturer name
 - c) Manufacturer model number (as it appears on manufacturer's product data sheet)
 - d) Manufacturer product description
 - e) Paragraph number of this section where the product is specified.
- C. Shop Drawings
1. Plan Drawing(s)
 - a. Depicting the location of all drops and major equipment locations at the project site, coordinate with work of related sections.
 2. Equipment Rack Elevations
 - a. Scaled
 - b. Depicting the locations of all system products installed within the rack, coordinated with work of other sections, as applicable.
 3. System block wiring diagram, detailed.

- D. Quality Assurance / Control Submittals
 - 1. RCDD Certification for the staff member responsible for this project.
 - 2. Resume of the last 10 projects of the RCDD responsible for this project
 - 3. BICSI Technician's certificate for each lead Technician(s) on the project
- E. Closeout Submittal
 - 1. Communication Room Rack Layouts, drawing to scaled, depicting devices and rack space occupied by each installed component.
 - 2. A diagram of the labeling scheme used on the Project.
 - 3. Additional closeout documentation as required in Division 1 and Division 27 "General Requirements for Communications".
 - 4. Cable manufacturer's certification of quality and performance.

1.6 WARRANTY

- A. Additional requirements: All cabling and connectivity products manufacturers, including patch cords, shall have in place an agreement recognizing each other for complete execution of warranty as specified. All performance and applications warranties shall be channel rated.
 - 1. The cable manufacturer and the connectivity products manufacturer shall have a partnership agreement established in order to provide the required warranty.
 - 2. Required warranty:
 - a. The ANSI/TIA/EIA 568-B Proposed Category 6 compliant cable system shall include as a minimum a 15 year extended product warranty and performance/applications assurance program up to 250 MHz systems.

PART 2 - PRODUCTS

2.1 GENERAL

- A. This section is designed to provide the Contractor with a minimum Basis of Design and functionality for the products used for telecommunications infrastructure.
- B. This standard will be considered in force for the original response as well as for any additions or changes to this Project. Due to this, there may be items listed in the Products section that are not required under the scope of this contract.
- C. Products required by the drawings but not listed in Part 2, will be evaluated as a performance specification based on the information provided on the Drawings.

2.2 CABLES

- A. General
 - 1. All cables on this Project shall be color-coded. Refer to Division 27 Section "Identification for Communications".
 - 2. CMP (OFNP) and CMR (OFNR) references below are as required by the NEC published by the National Fire Protection Association.

- a. Cables not specifically identified otherwise, shall be provided with CMP classification.
- b. Exceptions:
 - 1) Cables run end-to-end within a completely closed conduit system.
 - 2) Proper cable classification is ultimately determined by building construction; reductions in classification for cables, not clarified or altered by addendum to the specifications, shall require a contract cost deduction through a change order.

B. Twisted Pair Cables

- 1. Electrical Requirements:
 - a. All Twisted Pair cable is required to have the appropriate Category classification as defined by EIA/TIA/ANSI 568B. The compliance to these electrical characteristics must be third party verified by the manufacturer. Part 1 of this specification Section will define the appropriate Category for each cable.
 - b. Recognized Categories:
 - 1) Category 1-2, Category 3, Category 5e, Category 6
 - 2) All requirements and testing parameters as set forth by EIA/TIA 568B.
- 2. Construction
 - a. All Twisted pair cable will be properly constructed for the environmental conditions and to meet all applicable codes.
 - b. The following basic construction types are recognized for this Project:
 - 1) Premise Distribution 4 pair Cables - Category 6
 - a) Fully ANSI/EI/TIA 568B.1 Category 6 compliant
 - b) Cable shall have 2 individual insulated 24 AWG solid copper conductors formed into a twisted pair.
 - c) Cable must be constructed of four individually insulated Unshielded Twisted Pairs (UTP)
 - d) The cable construction must be available in plenum (CMP) and non-plenum riser (CMR) rated constructions.
 - e) This cable construction is used in indoor pathways primarily as horizontal cabling but may also be used as backbone cable.
 - f) Basis of Design shall be as manufactured by Panduit CMP (Confirm Color with CML)
(A) Additional approved manufacturer(s): CommScope and Hubbel

2.3 TERMINATION HARDWARE

A. General

- 1. Suggested layout of termination hardware is indicated on the Drawings. Coordinate layout of termination hardware with the Owner's Representative or Consultant/Architect/Engineer before installation.
- 2. Provide one single manufacturer for all twisted-pair termination hardware used together in a permanent link or whenever a Category Certification is required.
- 3. Termination devices on this Project shall be color-coded. ****See Detail
- 4. Drawings for details.

5. The manufacturer of the cable and the manufacturer of the connectivity products shall have a partnership agreement established in order to provide the required warranty. See Warranty requirements above and in related Section 27 00 01.00.
6. All devices shall be UL listed as required by the NEC published by the National Fire Protection Association.
7. All RJ-45 twisted pair termination devices are required to have the appropriate Category classification as defined by EIA/TIA/ANSI 568B. The compliance to these electrical characteristics must be third party verified by the manufacturer. Part 1 of this specification Section will define the appropriate Category for each cable.
 - a. Recognized Categories:
 - 1) Category 1-2, Category 3, Category 5e, Category 6, Category 6a.
 - 2) All requirements and testing parameters as set forth by the latest update to EIA/TIA 568B.

B. Station Outlet

1. The following basic termination devices are available and recognized for this Project.
 - a. Flush Faceplate – Single Gang Stainless Steel
 - 1) Single gang
 - 2) One Decora style opening
 - 3) 302 grade Stainless Steel
 - 4) Mountable on an outlet box, bracket, or raceway.
 - 5) Compatible with Decora Style Module Jack Frames specified herein.
 - 6) Basis of Design shall be Leviton 84401-040
 - a) Additional approved manufacturers: Commscope, Panduit, and Hubbell
 - b. Flush Faceplate – Double Gang Stainless Steel
 - 1) Double gang
 - 2) Two Decora style openings
 - 3) 302 grade Stainless Steel
 - 4) Mountable on an outlet box, bracket, or raceway.
 - 5) Compatible with Decora Style Module Jack Frames specified herein.
 - 6) Basis of Design shall be Leviton 84409-40
 - a) Additional approved manufacturers: Hubbell, Panduit, and Commscope
 - c. Furniture Faceplate
 - 1) Confirm item compatibility with Furniture Manufacturer On-Site
 - 2) 4 standard modular jack cutouts.
 - 3) Designed to snap into furniture knock-out.
 - 4) Basis of Design shall be Panduit CFFPL4BL
 - a) Additional approved manufacturers: Hubbell and Commscope.
 - d. Flush Faceplate – Single Gang
 - 1) Executive faceplate Frame
 - 2) Four position minimum on each faceplate
 - 3) Confirm color to match adjacent electrical devices; White color unless otherwise specified
 - 4) Mountable on an outlet box, bracket, or raceway.

- 5) Compatible with module inserts specified herein.
- 6) Basis of Design shall be Panduit CFPE4xxY
 - a) Additional approved manufacturers: Hubbell and Commscope.
- e. Flush Faceplate – Double Gang
 - 1) Executive faceplate Frame
 - 2) Ten position minimum on each faceplate
 - 3) Confirm color to match adjacent electrical devices; White color unless otherwise specified
 - 4) Mountable on an outlet box, bracket, or raceway.
 - 5) Compatible with module inserts specified herein.
 - 6) Basis of Design shall be Panduit CFPE10xx-2GY
 - a) Additional approved manufacturers: Hubbell and Commscope.
- f. Decora Style Module Jack Frame
 - 1) Four position minimum on each frame
 - 2) Confirm color to match adjacent electrical devices; White color unless otherwise specified
 - 3) Mountable on an outlet box, bracket, or raceway.
 - 4) Compatible with faceplates containing Decora style cut-out
 - 5) Basis of Design shall be Panduit CFG4xx
 - a) Additional approved manufacturers: Hubbell and Commscope.
- g. Duplex Module Quad Jack Frame
 - 1) Four position minimum on each frame
 - 2) Confirm color to match adjacent electrical devices; White color unless otherwise specified
 - 3) Mountable on an outlet box, bracket, or raceway.
 - 4) Compatible with faceplates containing standard electrical duplex receptacle cut-out.
 - 5) Basis of Design shall be Panduit CF1064xxY
 - a) Additional approved manufacturers: Hubbell and Commscope.
- h. Faceplate Blank Insert
 - 1) Provide blanks for all un-used positions in faceplates, surface boxes, or jack frames.
 - 2) Color to match outlet faceplate as described above; White color unless otherwise specified
 - 3) Basis of Design shall be Panduit CMBxx-X
 - a) Additional approved manufacturers: Hubbell and Commscope.
- i. Wall-Phone Jack
 - 1) Stainless Steel faceplate with mounting posts for keyhole slot telephone mounting
 - 2) Mountable on an outlet box, bracket, or raceway.
 - 3) Basis of Design shall be Panduit KWP6PY
 - a) Additional approved manufacturers: Hubbell and Commscope.
- j. F style bulkhead Insert
 - 1) Female to Female 75 ohm bulkhead connector.

- 2) Color to match outlet faceplate as described above; White color unless otherwise specified
- 3) Basis of Design shall be Panduit CMFSRxxY
 - a) Additional approved manufacturers: Hubbell and Commscope.

C. Communications Room Equipment Rack(s)

1. The following basic termination devices are available and recognized or this Project.
 - a. UTP Cat 6 Patch Panel 24 port
 - 1) Panel shall be black steel with PCB connection between interfaces
 - 2) Shall provide 24 ports in 1.75" of rack space (1 RU).
 - 3) Designed with jack labeling areas on both front and rear
 - 4) Fully compliant ANSI/TIA/EIA 568B Category 6
 - 5) RJ45 jack interface on front and 110 style IDC connections on rear
 - 6) Mountable in EIA standard 19" rack/cabinet rails.
 - 7) Basis of Design shall be Panduit DP24688TGY
 - a) Additional approved manufacturers: Hubbell and Commscope.
 - b. UTP Cat 6 Patch Panel 48 port
 - 1) Panel shall be black steel with PCB connection between interfaces
 - 2) Shall provide 48 ports in 3.5" of rack space (2 RU).
 - 3) Designed with jack labeling areas on both front and rear
 - 4) Fully compliant ANSI/TIA/EIA 568B Category 6
 - 5) RJ45 jack interface on front and 110 style IDC connections on rear
 - 6) Mountable in EIA standard 19" rack/cabinet rails.
 - 7) Basis of Design shall be Panduit DP48688TGY
 - a) Additional approved manufacturers: Hubbell and Commscope.
 - c. 110 Block Mounting Panel
 - 1) Panel shall be black steel pre-drilled for mounting standard 110 style devices and trough hardware Mountable in 4 rack spaces (7.00") EIA standard 19" rack/cabinet rails.
 - 2) Must use separate 110 style blocks and hardware listed under Wall Mounted Terminations below – Order without legs.
 - 3) Basis of Design shall be Panduit P110B100R4BY
 - a) Additional approved manufacturers: Hubbell and Commscope.
 - d. 110 style 100 pair base
 - 1) Shall utilize Industry normal footprint
 - 2) Must have labeling areas on front and available label kits
 - 3) Fully compliant ANSI/TIA/EIA 568B Category 5e
 - 4) 110 style IDC termination system
 - 5) Optional jumper troughs available and designed to mount with base footprint
 - 6) Requires 110C connecting blocks below
 - 7) Available without legs for mounting on rack/cabinet mounted panels or on Tower Systems
 - 8) Basis of Design shall be Panduit P110BW100-X with legs and Panduit P110B100-X without legs

- a) Additional approved manufacturers: Hubbell and Commscope.
 - e. 110 style 300 pair base
 - 1) Shall utilize Industry normal footprint
 - 2) Must have labeling areas on front and available label kits
 - 3) Fully compliant ANSI/TIA/EIA 568B Category 5e
 - 4) 110 style IDC termination system
 - 5) Optional jumper troughs available and designed to mount with base footprint
 - 6) Requires 110C connecting blocks below
 - 7) Available without legs for mounting on rack/cabinet mounted panels or on Tower Systems
 - 8) Basis of Design shall be Panduit P110BW300-X with legs and Panduit P110B300-X without legs
 - a) Additional approved manufacturers: Hubble, Leviton, Ortronics
 - f. 110 style connecting Block – 4 pair
 - 1) Fully compliant ANSI/TIA/EIA 568B Category 5e 110 style IDC termination system
 - 2) Used for termination of 4 pair cables or a combination of 4 pair and multi-pair cables
 - 3) Basis of Design shall be Panduit P110CB4-XY
 - a) Additional approved manufacturers: Hubbell and Commscope.
 - g. 110 style connecting Block – 5 pair
 - 1) Fully compliant ANSI/TIA/EIA 568B Category 5e
 - 2) 110 style IDC termination system
 - 3) Used for termination of multi-pair cables
 - 4) Requires 110C connecting blocks below
 - 5) Basis of Design shall be Panduit P110CB5-XY
 - a) Additional approved manufacturers: Hubbell and Commscope.
 - h. 110 style Jumper Trough with legs
 - 1) Used for wire management around 110 style termination bases
 - 2) Available without legs for mounting on rack/cabinet mounted panels or on Tower Systems
 - 3) Basis of Design shall be Panduit P110JTW-X with legs and P110JT-X without legs
 - a) Additional approved manufacturers: Hubbell and Commscope.
- D. Discrete Cable Connectors
- 1. The following basic termination devices are available and recognized on this Project:
 - a. Category 6 RJ-45 modular plug for solid cable.
 - 1) Each plug will use an insulation displacement pressure termination method with specifically designed installation tool.
 - 2) The plug shall be 8 position; 8 conductor.
 - 3) Designed for 23 gauge solid copper conductors.
 - 4) The strain relief of the plug shall be designed for clamping on round cable.

- 5) Basis of Design shall be Panduit SP688-C
 - a) Additional approved manufacturers: Hubbell and Commscope.

PART 3 - EXECUTION

3.1 GENERAL

- A. This section is designed to provide a Basis of Design and functionality for the installation of technology systems infrastructure. Not all procedures will be necessary for the installation of this Project; however, this standard shall be considered in force for the original response as well as for any additions or changes to this Project.

3.2 INSTALLATION

- A. Coordination
 1. Review and coordinate proper pathways prior to installation.
 2. Reference the TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL (TDMM) published by the Building Industry Consulting Services International (BICSI) for cable installation practices. This Specification may take exception to optional statements within the TDMM. Treat any conflict per this Specification under discrepancies or Conflicts.
- B. General
 1. Cable routing shall follow building structure lines and shall be installed with adequate length to reach to any location within the equipment racks with at least 5 feet of service loop at each end.
 2. At point of final terminations, excess cable and the service loop shall be stored and dressed neatly.
 - a. At the station end of the cable the service loop shall be stored above the ceiling line at an accessible point and supported with an approved device designed for that purpose.
 - b. Within a communications room the service loop shall be dressed and stored within the ladder rack.
 3. Provide strain relief at all connection points. Strain relief techniques shall be applied to all cables to lessen the risk of physical cable damage and to provide proper aesthetic value.
 4. Route all cabling and pathways parallel to building surfaces and at 90 degree angles to the building structure.
 5. Cable runs shall be continuous and without splices.
 6. Wiring shall be free from grounds, shorts, opens, and reversals.
- C. Protection
 1. Maintain protection of all cabling throughout the entire duration of the project.
 2. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other contractors or trades. Cabling shall be bundled, supported, and protected up out of the way of other trades any time it is determined necessary to ensure the safety of personnel or protection of the cable.

3. Do not terminate cables designated for different services onto the same patch panel unless otherwise clearly indicated on the drawings.
 4. Do not exceed minimum bend radius or pulling tension specifications set forth by the product manufacturer.
 5. Cable Separation and Organization
 - a. Cables of different services shall not be intertwined.
 - b. Cables of all service types shall be organized and kept segregated within cable trays, ladder rack, wire management and other pathways.
 - c. Terminate all cabling on specified termination hardware in numerical order and on specified outlets.
- D. Labeling
1. Every cable shall have a label applied to the jacket at each end.
 2. Each terminating device and port shall have a unique identifier.
 3. Label all cabling and terminations as specified and indicated on related drawings.
- E. Raceways
1. Install cabling within conduit or in surface raceway where specified in this or related sections or as indicated on the drawings.
 - a. Surface raceway is permissible for use only where expressly indicated on the drawings.
 2. Cabling shall be installed in a concealed manner. Cables may be visible only in the following areas. (Provide concealed rough-ins for all device and outlet locations.)
 - a. Equipment Rooms
 - b. Telecommunications Rooms
 - c. Building spaces equipped with cable trays but without finished ceilings to conceal the cables.
 3. Install cabling in cable tray and ladder rack where specified in this or related sections or as indicated on the drawings.
 4. Support cables using approved products and methods whenever conduit, surface raceway or cable tray are not specified. Cable supports shall be attached directly to building structure.
 5. Entry/exit from raceways shall be made in a uniform and consistent manner and shall not exceed the minimum bend radius of the cable.
 6. Route all cabling and pathways parallel or at 90 degree angles to the structure.
 7. Support cabling with the appropriate cable supports and from the building structure.
- F. Wall and Floor Penetrations
1. Provide conduit sleeves with bushings on each end for all cabling penetrations. Split bushings shall not be permitted. Patch and firestop around the sleeve. Firestop the interior of the sleeve after cable is installed.
 2. Firestop all firewall penetrations to return the wall to its original rating. Outlet boxes installed in firewalls shall be similarly firestopped.
- G. Cable Supports
1. Neatly dress, support and securely attach all cabling on backboards and in equipment racks.

2. Where cabling is not supported by cable tray or conduit, provide necessary cable support as specified. Provide nylon cable tie at the support to contain cabling within the support. Do not bundle cable between supports. Provide cable support as specified at intervals not to exceed 5 feet. Do not secure cabling to the support. Do not use cable supports with round surfaces (i.e. bridal rings).
 3. Route all cabling and pathways parallel or at 90 degree angles to the structure. Support cabling with the appropriate cable supports and from the building structure.
- H. Termination
1. Terminate each end of every cable per the manufacturer's printed instructions.
 2. Terminate each cable in numerical order on adjacent ports on the specified termination hardware within the appropriate communications room.
 3. Terminate cables using the tools and connectors specified and as recommended by the cable/connector manufacturers' printed instructions.
- I. Separation from Sources of Interference
1. Route cables at least 1.2m (4 foot) from motors or transformers; 30 cm (1 foot) from conduit and cables used for AC power distribution; 12 cm (5 inches) from fluorescent lighting fixtures.
- J. Horizontal cabling
1. The length of patch cords and cross connect jumpers installed in the Telecommunications Room shall be 5 m (15 ft) total or less.
 2. The length of patch cords and cross connect jumpers installed in the Equipment Room shall be 5 m (15 ft) total or less.
 3. Locate telecommunications outlets so that the cable assembly required to reach work area equipment will be no more than 5 m (15 ft) long.
 4. Furnish and install Panduit, or matching cabling manufacturer, CAT-6 patch cords (two cables, length to be determined as needed for each cable run provided).
 5. Provide service loops on all cables at the station end of 2 feet (coiled above the ceiling and with a minimum of 6 inches at the telecommunications outlet coiled in the box or raceway).
 6. Provide service loop at the Equipment Room/Telecommunications Room end of 5 feet coiled above the ceiling or neatly bundled in ladder rack above the cabinet/rack.
 7. Install telecommunications outlets securely at work area locations.
 8. Any necessary electrical components (e.g., impedance-matching devices) at outlets shall be located outside the faceplate via a standard plug connection.
 9. Provide surface raceway on all walls where existing pathway has not been provided and cables cannot be concealed inside the wall cavity. Do not conceal cabling inside of block walls. Install surface raceway plumb and level, straight and securely anchored to walls with screws, bolts, or anchors as appropriate.
 10. Provide a 6 inch service loop on each horizontal UTP cable that breaks out from the harness for termination and do not violate the minimum bend radius of the cable.

3.3 TESTING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- E. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
 - 1. Prepare test and inspection reports.
- H. The Owner reserves the right to have a representative present during any or all testing procedures. Verification testing of copper and fiber may be performed at or near Project completion by the Consultant for quality assurance.
- I. Upon verification testing, if the Consultant finds the test results do not match the Contractor's results, the Consultant or a third party may at the Owner's request retest all of the cabling and submit those results to the Owner and deduct the verification testing costs from the Contractor's Contract amount.

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SECTION 27 33 00

PUBLIC ADDRESS SYSTEM

PART 1 - GENERAL

1.1 Summary

- A. General: The Contractor shall provide the labor, tools, equipment, and materials necessary to furnish a complete Public Address (PA) system in accordance with the plans and as specified herein. The contractor shall install all speakers, horns, cables and cable to be run to the main communications room. The Contractor shall make all connections and install all equipment in the communications room. The Contractor shall coordinate exact equipment mounting locations with the Owner prior to the installation of any equipment or cabling.

1.2 Quality Assurance

- A. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, regulations, and the requirements of the authorities having jurisdiction.
- B. Comply with NFPA 70.
- C. Listing and Labeling: Provide PA system components specified in this Section that are listed and labeled by Underwriters' Laboratories, Inc. (UL).
- D. PA System shall be registered under Part 68 of the Federal Communications Commission (FCC).

1.3 Submittals

- A. Submit product data for each type of proposed system component specified, including dimensioned drawings showing minimum clearances and installed features and devices. Include list of materials and NRTL-listing data.
- B. Submit Shop Drawings showing detailed drawings of PA system.
- C. Submit wiring diagrams from manufacturer differentiating clearly between factory and field-installed wiring. Include diagrams for each component of the system with all terminals and interconnections identified. Make all diagrams specific to this Project.
- D. Submit a system operation description covering this specific Project, including method of operation. Manufacturer's standard descriptions for generic systems are unacceptable.

- E. Submit product certificates signed by the manufacturer of the PA system components certifying that their products comply with specified requirements.
- F. Submit the manufacturer's warranty.

1.4 Delivery, Handling, And Storage

- A. Deliver PA system components in factory fabricated containers or wrappings, which properly protect products from damage.
- B. Handle PA system components carefully to prevent breakage, denting and scoring finish. Wrap finished cabinets individually, in heavy containers for protection in transit. Do not install damaged units or components; replace with new.
- C. Store PA system components in original cartons in well ventilated space protected from moisture, construction traffic and debris.

1.5 Sequence of Operation

- A. The PA system shall be zone based for direct connection to loop start and ground start trunks, to PBX and KEY paging ports that supplies DTMF capability and to analog T/R lines.
- B. The system shall allow total amplifier power up to 250W.
- C. Momentary tones shall be placed throughout the system when a contact closure is received from the master clock of the building automation system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide the following equipment including, but not limited to, the following:
 - 1. Bogen PCM 2000 series (Basis of design)

2.2 HEADEND EQUIPMENT

- A. All modules shall be equipped with a ribbon cable, connector and power cable for interconnection to each other. Module face plates shall be black with connector types labeled in white. Each plate shall have knockouts for cabling and wire dressing. All connectors shall be RJ-11 or RCA type.
- B. Central Processor Module (CPU) shall be provided for the first 9 zones of the system. CPU shall provide satellite system identification via DIP switches. It shall include a locking program/run selector switch (with LED), satellite data link RCA jack and 12VDC power source. A connector block with screw terminals shall be provided for paging

amplification connections, low and high power BGM connections, emergency/shift change signal activation, AUX contact closure and 12VDC power source. Bogen PCMCPU with Bogen PCMPS2 power supply and Bogen RPK88 rack mount kit.

- C. A zone paging module (Bogen PCMZPM) provides three zones of paging to the PCM2000 system. Up to three PCMZPM modules can be used in the basic system, providing up to nine zones of paging. Each zone module allows talkback (on/off) and background music (BGM) options for each zone. Each zone can be connected or disconnected from the background music bus; the entire module can be disconnected from the BGM bus and connected to its own local BGM source. Each module also supports either high-power (passive speakers / central amplifier) or low-power (low level signals to amplified speakers). A relay driver is available per zone, activating when the zone is active. Additional zone paging modules can be combined with additional PCMCPU modules when more than nine zones are required.
- D. Telephone interface module shall have LED power indicator and provide interface selection via DIP switches and include volume control for tone and BGM source. It shall also have RJ-11 outlets for night ringer, telephone line and override functions. A connector block with screw terminal connections shall be provided for BGM source and 2 form-C relay contacts (Bogen PCMTIM).
- E. A talkback module (PCMTBM) shall be provided for hands-free talkback capability and time-triggered signaling events.
- F. The Zone PA system shall have the following functions:
 - 1. Simultaneous high and low power paging.
 - 2. Minimum of 3 paging zones and maximum capacity of 99 zones, expandable in groups of 3 zones.
 - 3. Up to 32 field programmable zone groups, each consisting of 1 – 99 zones.
 - 4. Field programmable night ringer zone group.
 - 5. Field programmable emergency/shift change zone group. This feature shall be activated by an Owner supplied contact closure and sound a user-selected tone.
 - 6. Emergency all-facility page override.
 - 7. Background music with local music sourcing capability.
 - 8. Field programmable Code Call Zone Group. Owner shall have choice of pattern or echo code calls and repeat functions.
 - 9. 2 Form-C relay contactors for activating external equipment.
 - 10. Provide uninterrupted background music to zones not being paged.
 - 11. Non-volatile RAM for retention of programming information during power interruptions.
 - 12. Screwdriver adjustable volume controls.
- G. VoIP tie in module to enable access from IP phone system to paging system. Coordinate with Owner's phone system vendor.
- H. The single channel central amplifier shall be rack mountable, and capable of supporting 25V or 70V loads. Total Harmonic Distortion of less than 0.5% and Frequency Response of +0/-2dB from 65 to 20,000 Hz at full rated output. The amplifier shall be loaded to a max of 80% of capacity. Bogen GS150D (125 watts) or Bogen GS250D (250 watts). Provide with Bogen GSDRPK rack mount kit.

2.3 ADDITIONAL EQUIPMENT

- A. Rack
 - 1. Provide equipment in data racks as specified in Section 27 11 16 "Communications Cabinets, Racks, Frames and Enclosures".
- B. Recessed Ceiling Speakers
 - 1. Provide a complete speaker/transformer/baffle/backbox/tile bridge assembly, designed for drop-tile ceiling installations.
 - 2. 8" O.D. speaker with 10 oz magnet and a 5W, 25/70V transformer with five tap settings between 0.31W and 5W (C10X/BU/WS w/ TBLU).
 - 3. Round, steel stud-mount baffle, with white powder coat finish (BR8WS)
 - 4. Rust-resistant steel, load bearing support bridge (SSB-3)
 - 5. Round, steel, 275 CID backbox (ERD8U)
 - 6. Quam Solution 1 (two complete speaker assemblies of the above components) or approved equal by Rauland or Atlas.
- C. Drop in Ceiling Tile Speakers
 - 1. UL listed, shallow depth lightweight speaker assembly, 1' x 2' ceiling tile loudspeaker system consisting of 8" O.D. dual cone loudspeaker with 5 oz. magnet and 5W-25/70V transformer.
 - 2. Quam 8C5PAX/TBLU or approved equal by Rauland or Atlas.
- D. Paging Horns
 - 1. Compression type, double re-entrant horn loudspeaker with an integrated 15W, 25/70V rotary select transformer and an adjustable mounting base.
 - 2. Five tap settings between 1W and 15W.
 - 3. Indoor or outdoor environment.
 - 4. 110-degree coverage angle.
 - 5. Quam QH16T or approved equal by Rauland or Atlas.
- E. Wall Mount Volume Control
 - 1. Single gang, 20 watt, ten-step continuous rotary audio level attenuator with an "off" position.
 - 2. Stainless steel faceplate with embossed positions and central knob with indicator mark.
 - 3. Quam QC10 or approved equal by Rauland or Atlas.
- F. Cabling
 - 1. Speaker cabling shall be plenum rated, 2-conductors twisted pair, 18-gauge stranded copper.
 - 2. West Penn 25224B or approved equal by General or Belden.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install system according to standards referenced in Part 1 of this Section.

3.2 EQUIPMENT INSTALLATION

- A. Install ceiling/wall mounted speakers and other equipment per manufacturer's recommendation.
- B. Flush wall mount volume controller as required.

3.3 WIRING INSTALLATION

- A. Wiring Method: Install paging system wiring in metal conduit where concealed and inaccessible, such as within walls and enclosed ceilings. Wiring above accessible ceilings may be routed in J-hooks. Where low voltage cable tray is available, speaker cables can be routed within.
- B. Final termination in the main communications room will be by the Contractor.
- C. Speaker circuits shall be designed not to exceed a 5 percent voltage drop.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification for Electrical Systems."

3.5 GROUNDING

- A. Ground equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.
- B. Ground equipment, conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

3.6 FIELD QUALITY CONTROL

- A. Minimum System Tests: The minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Test all conductors for short circuits using an insulation-testing device.
 - 3. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
- B. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests. A copy of the test reports shall be included in the Owner's O&M Manual.

- C. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

END OF SECTION 27 33 00

SECTION 28 13 00

ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Security access control station.
 - 2. Security access networked workstations.
 - 3. Security access operating system and application software.

1.2 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. CPU: Central processing unit.
- C. Credential: Data assigned to an entity and used to identify that entity.
- D. dpi: Dots per inch.
- E. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- F. GFI: Ground fault interrupter.
- G. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- H. I/O: Input/Output.
- I. LAN: Local area network.
- J. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- K. PC: Personal computer. Applies to the central station, workstations, and file servers.
- L. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

- M. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.
- N. RAS: Remote access services.
- O. RF: Radio frequency.
- P. ROM: Read-only memory. ROM data are maintained through losses of power.
- Q. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- R. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
- S. UPS: Uninterruptible power supply.
- T. USB: Universal serial bus.
- U. WAN: Wide area network.
- V. WAV: The digital audio format used in Microsoft Windows.
- W. WMP: Windows media player.
- X. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- Y. Windows: Operating system by Microsoft Corporation.
- Z. Workstation: A PC with software that is configured for specific, limited security-system functions.
- AA. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.

3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
4. Cable Administration Drawings: As specified in "Identification" Article.
5. Battery and charger calculations for central station, workstations, and controllers.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Microsoft Windows software documentation.
 2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
 3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
 4. System installation and setup guides with data forms to plan and record options and setup decisions.

1.5 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. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70, "National Electrical Code."
- E. Comply with SIA DC-01 and SIA DC-03 and SIA DC-07.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Central Station, Workstations, and Controllers:
 - 1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F (10 and 30 deg C), and not more than 80 percent relative humidity, noncondensing.
 - 2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
 - 3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
 - 4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 - 2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products by the following:
 - 1. Kantech (Tyco)
 - 2. or Owner approved equal.

2.2 DESCRIPTION

- A. Security Access System: Field-installed controllers, connected by a high-speed electronic-data transmission network.
- B. System Software: Based on 32-bit central-station, Windows workstation operating system, server operating system, and web based application software. Software shall have the following capabilities:
 - 1. Multiuser and multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations.

2. Graphical user interface to show pull-down menus and a menu-tree format that complies with interface guidelines of Microsoft Windows.
 3. System license for the entire system including capability for future additions that are within the indicated system size limits specified in this Section.
 4. Open-architecture system that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows.
 5. Password-protected operator login and access.
 6. Open-database-connectivity compliant.
- C. Network connecting the central station and workstations shall be a LAN using Microsoft Windows-based TCP/IP with a capacity of connecting up to 21 workstations. System shall be portable across multiple communication platforms without changing system software.
- D. Controllers shall consist of one or more of the following:
1. Local area, IEEE 802.3 Gigabit-Ethernet, star topology network based on TCP/IP.
 2. Dialer using standard telephone line.

2.3 OPERATION

- A. Security access system shall use a single database for access-control and credential-creation functions.
- B. Distributed Processing: A fully distributed processing system.
1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
 2. Intermediate controllers for access control are prohibited.
 3. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the central station.
- C. Number of Locations:
1. Support at least for 2500 readers, 10,000 inputs and outputs, 500,000 personnel records, 100 simultaneous client connections and 10 badging clients.
 2. Each Location shall have its own database and history in the central station.
 3. Locations may be combined to share a common database.
- D. Data Capacity:
1. 250 different card-reader formats.
 2. 999 comments.
 3. Support for Raster and Vector graphic file types for importing maps.
- E. Location Capacity:
1. 250 reader-controlled doors.
 2. 50,000 total-access credentials.
 3. 2048 supervised alarm inputs.
 4. 2048 programmable outputs.

5. Ability to create Predefined Log Messages. These messages may be assigned to any event providing the ability to select the appropriate response during event management process. The SMS provides the ability to group multiple log messages and then assign the group to an event. Each group may contain up to one hundred messages and each event supports up to one hundred predefined log messages..
- F. System Network Requirements:
1. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
 2. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
 3. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.
 4. Communications controller may be used as an interface between the central-station display systems and the field device network. Communications controller shall provide functions required to attain the specified network communications performance.
- G. Central station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central station shall control system networks to interconnect all system components, including workstations and field-installed controllers.
- H. Field equipment shall include controllers, sensors, and controls.
1. Controllers shall serve as an interface between the central station and sensors and controls.
 2. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.
 3. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
 4. Controllers are classified as alarm-annunciation or entry-control type.
- I. System Response to Alarms:
1. Field device network shall provide a system end-to-end response time of one second(s) or less for every device connected to the system.
 2. Alarms shall be annunciated at the central station within one second of the alarm occurring at a controller or at a device controlled by a local controller, and within 100 ms if the alarm occurs at the central station.
 3. Alarm and status changes shall be displayed within 100 ms after receipt of data by the central station.
 4. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.
 5. This response time shall be maintained during system heavy load.
- J. False-Alarm Reduction: The design of the central station and controllers shall contain features to reduce false alarms. Equipment and software shall comply with UL 1076.

- K. Error Detection:
 - 1. TCP/IP tools that employs sequence numbers and acknowledgments to cover discarding duplicate packets, retransmission of lost packets, and ordered-data transfer. To assure correctness a checksum field is included and an operator assignable two digit decimal number for each communication link representing the number of retransmission attempts is not supported..
 - 2. Interactive or product error-detection codes alone will not be acceptable.
 - 3. A message shall be in error if one bit is received incorrectly.
 - 4. Retransmit messages with detected errors.
 - 5. Allow for an operator-assigned two-digit decimal number to each communications link representing the number of retransmission attempts.
 - 6. Central station shall print a communication failure alarm message when the number of consecutive retransmission attempts equals the assigned quantity.
 - 7. Monitor the frequency of data transmission failure for display and logging.
- L. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.
- M. Door Hardware Interface:
 - 1. Comply with requirements in Section 087100 "Door Hardware" and Section 087111 "Door Hardware (Descriptive Specification)" for door hardware required to be monitored or controlled by the security access system.
 - 2. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

2.4 APPLICATION SOFTWARE

- A. System Software: Based on 32-bit, Microsoft Windows central-station and workstation operating system and web based application software.
- B. Software House C•CURE 9000 (no exception). System software shall provide full fault tolerance to multi-processor applications that require 100% uptime. It combines the physical resources of two standard Windows servers into a single operating environment with complete redundancy of all underlying hardware and data. It presents these redundant servers as a single operating environment to keep the C•CURE 9000 running in the event of component or system failures. Software shall manage the two physical host machines such that critical host failures on either server will still result in application (C•CURE 9000) availability via the redundant host. Application availability is not affected during failover instances and users should not notice any transition to the redundant host. Conversely, any return to normal operation should equally go unnoticed and no loss of performance will be caused in either instance.
- C. Application Software: Interface between the alarm annunciation and entry-control controllers to monitor sensors, operate displays, report alarms, generate reports, and help train system operators.
 - 1. Reside at the central station, workstations, and controllers as required to perform specified functions.
 - 2. Operate and manage peripheral devices.

3. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
4. Import custom icons into graphics to represent alarms and I/O devices.
5. Globally link I/O so that any I/O can link to any other I/O within the same Location without requiring interaction with the host PC. This operation shall be at the controller.
6. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host PC. This operation shall be at the controller.
7. Messages from PC to controllers and controllers to controllers shall be on a polled network that utilizes check summing and acknowledgment of each message. Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.
8. Network ready controller providing user configurable timing intervals for verifying connections from the host to the master controller.
9. Operator audit trail for recording and reporting all changes made to database and system software.
10. TCP/IP communications over LAN or WAN. VPN access capable.

D. Workstation Software:

1. Operator access to various functions and operations in the CCURE9000 Administration and Monitoring Client applications are based on the configuration of the operator's privilege. CCURE9000 supports an unlimited number of privileges, where the same privilege can be assigned to multiple operators.

E. Controller Software:

1. Controllers shall operate as autonomous, intelligent processing units.
 - a. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
 - b. Controllers shall be part of a fully distributed processing-control network.
 - c. The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.
2. The following functions shall be fully implemented and operational within each controller:
 - a. Monitoring inputs.
 - b. Reporting of sensor and output status to the central station on request.
 - c. Maintaining real time, automatically updated by the central station at least once a day.
 - d. Communicating with the central station.
 - e. Executing controller resident programs.
 - f. Diagnosing.
 - g. Downloading and uploading data to and from the central station.
3. Controller Operations at a Location:
 - a. Up to 64 controllers connected to TIA 485-A communications loop. Globally operating I/O linking and anti-passback functions between controllers within the same Location without central-station or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the central station or workstations are off-line.

4. Individual Controller Operation:
 - a. Controllers shall transmit alarms, status changes, and other data to the central station when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the central station, shall be stored for later transmission to the central station. Storage capacity for the latest 1024 events shall be provided at each controller.
 - b. Card-reader ports of a controller shall be custom configurable for at least 10 different card formats.
 - c. Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
 - d. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
 - e. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
 - f. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
 - g. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.
 - h. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the central station.
 5. Communications Monitoring:
 - a. System controller communicates to server via TCP/IP and monitors the supervision of associated field equipment such as RM and I/O modules via 2 wire RS-485 protocol. Triggers can be configured to activate events when any module is in communication failure
 6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.
- F. PC-to-Controller Communications:
1. System shall utilize a single, industry-standard relational database management system for the storage and manipulation of related data. The system includes a server with operating system and applications software, operator and administrator terminals with appropriate software, hard copy printers and fixed magnetic storage media. The system client workstations and controller communicate to the application server via TCP/IP over Ethernet. Other third party field devices may communicate to server Ethernet 10/100 or a serial (RS-232, RS-485) connection.
- G. Database Downloads:

1. System controller performs a "Fast Personnel Download" when initial communications to controller is established. All new, deleted and modified records are immediately downloaded to the controller as they are committed. No manual download process is required.
 2. Controller provides an onboard Ethernet connection and supports a PCMCIA Ethernet card as a secondary communication path.
- H. Operator Interface:
1. System supports the placement of an icon representing an event that may be configured to change the status of multiple objects.
- I. Operator Access Control:
1. Operator access to various functions and operations in the system Administration and Monitoring Client applications are based on the configuration of the operator's privilege. The system supports an unlimited number of privileges, where the same privilege can be assigned to multiple operators.
- J. Operator Commands:
1. The system allows devices to be placed in an offline state to facilitate the phased deployment and testing of remote field devices.
- K. Alarms:
1. System Setup:
 - a. Assign manual and automatic responses to incoming-point status change or alarms.
 - b. Automatically respond to input with a link to other inputs, outputs, or operator-response plans; unique sound with use of WAV files; and maps or images that graphically represent the point location.
 - c. Sixty-character message field for each alarm.
 - d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages. Setup shall assign messages to access point, sensor.
 - e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
 - f. Allow 25 secondary messages with a field of four lines of 60 characters each.
 - g. Store the most recent 1000 alarms for recall by the operator using the report generator.
 2. Software Tamper:
 - a. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond the authorization level.
 - b. Maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
 - c. Allow only acknowledgment of software tamper alarms.
 3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
 4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.

5. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
 6. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
 7. Alarm Automation Interface: High-level interface to central-station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in the same manner as burglar alarms, using a TIA 232-F ASCII interface.
 8. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.
 9. Camera Control: Provides operator ability to select and control cameras from graphic maps.
- L. Alarm Monitoring: Monitor sensors, controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.
1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
 2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
 3. Maps shall automatically display the alarm condition for each input assigned to that map if that option is selected for that input location.
 4. Alarms initiate a status of "pending" and require the following two handling steps by operators:
 - a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
 5. Each workstation shall display the total pending alarms and total unresolved alarms.
 6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
 7. Alarms shall transmit to the central station in real time except for allowing connection time for dial-up locations.
 8. Alarms shall be displayed and managed from a minimum of four different windows.
 - a. Input Status Window: Overlay status icon with a large red blinking icon.
 - b. History Log Transaction Window: Display name, time, and date in red text.
 - c. Alarm Log Transaction Window: Display name, time, and date in red.
 - d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
 9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.

10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
 11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
 12. Identical alarms from the same alarm point shall be acknowledged at the same time the operator acknowledges the first alarm.
 13. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and controllers.
 14. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.
- M. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.
1. Color Code:
 - a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
 - b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged. (Changes to yellow when active event is acknowledged until event cause has expired).
 - c. YELLOW: Advises operator that a zone is in access.
 - d. GREEN: Indicates that a zone is secure and that power is on.
 2. Graphics:
 - a. Support Raster and Vector graphic display maps and allow import of maps from standard formats from another drawing or graphics program.
 - b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
 - c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on the graphic map.
 - d. Inputs or outputs may be placed on multiple graphic maps.
 - e. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
 - f. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.
- N. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.
1. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.
- O. Report-Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest-priority activity. Report-generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.
1. Automatic Printing: Setup shall specify, modify, or inhibit the report to be generated; the time the initial report is to be generated; the time interval between reports; the end of the period; and the default printer.
 2. Printing on Request: An operator may request a printout of any report.

3. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm such as door alarm, motion detector, door contact, etc.), the type of sensor, the location, the time, and the action taken.
4. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
5. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
6. Automatic History Reports: Named, saved, and scheduled for automatic generation.
7. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
8. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
9. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
10. Provide an Area Muster feature and a default "Roll Call" report which display's the list of personnel presently accessed to an area. Some modifications and/or customizations to the report may be made to include Area Access Time, etc.
11. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that data are available on-site at all times.
12. History Reports: Custom reports that allow the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.

P. Anti-Passback:

1. System shall supports Areas with Anti-passback allowing for hard and timed Anti-passback as well as an Occupancy feature allowing for the setting of Minimum and Maximum occupancy. Soft anti-passback may be configured whereby certain cardholders may be flagged as exempt from anti-passback checking or configured to activate or not activate an anti-passback event. Anti-Passback is an iSTAR Area function (not at individual door level) and is supported at the Cluster and Cross Cluster (Global) level.

2.5 CONTROLLERS

- A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation.
- B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.
- C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 24 hours.
- D. Alarm Annunciation Controller:

1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network.
 - a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
 - b. Alarm-Line Supervision:
 - 1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal by monitoring for abnormal open, grounded, or shorted conditions using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 10 percent or more for longer than 500 ms.
 - 2) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.
 - c. Outputs: Managed by central-station software.
 2. Auxiliary Equipment Power: A GFI service outlet inside the controller enclosure.
- E. Entry-Control Controller:
1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
 - a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
 - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
 - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
 - 2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
 - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
 2. Inputs:
 - a. Data from entry-control devices; use this input to change modes between access and secure.
 - b. Database downloads and updates from the central station that include enrollment and privilege information.
 3. Outputs:
 - a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
 - b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
 - c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.

- d. Door Prop Alarm: If a portal is held open for longer than 20 seconds, alarm sounds.
- 4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
- 5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
 - a. Store up to 1000 transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.
- 6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
 - a. Backup Battery: Sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata 8-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
 - b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
 - c. Backup Power-Supply Capacity: 24 hours of standby supply. Submit battery and charger calculations.
 - d. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
 - 1) Trouble Alarm: Normal power-off load assumed by battery.
 - 2) Trouble Alarm: Low battery.
 - 3) Alarm: Power off.

2.6 CARD READERS AND KEYPADS

- A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
- B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
- C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:
 - 1. Indoors, controlled environment.
 - 2. Indoors, uncontrolled environment.

3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.
- D. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
- E. Proximity Readers:
 1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction and shall receive and decode a unique identification code number transmitted from the credential card.
 2. The card reader shall read proximity cards in a range from direct contact to at least 6 inches (150 mm) from the reader.
- F. Keypads:
 1. Entry-control keypads shall use a unique combination of alphanumeric and other symbols as an Identifier.
 2. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII-code ordinal sequence.
 3. Keypad shall provide staff functions such as (but not limited to):
 - a. Arming system
 - b. Disarming system
 - c. Reset
 - d. Silencing alarm
 4. Communication protocol shall be compatible with the local processor.
- G. Keypad Response Time:
 1. The keypad shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 ms or less from the time the last alphanumeric symbol is entered until a response signal is generated.
- H. Keypad Power:
 1. The keypad shall be powered from the source as shown and shall not dissipate more than 150 W.
 2. The keypad shall be equipped with a 24 hour battery backup.
- I. Keypad Mounting Method:
 1. Keypads shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
- J. Communication Protocol: Compatible with local processor.

2.7 PUSH-BUTTON SWITCHES

- A. Push-Button Switches: Momentary-contact back-lighted push buttons with stainless-steel switch enclosures.
 1. Push-button signals shall report to 911 and to CML Main security control center.
 2. Lockdown push-button signals shall also activate magnetic locks with solenoids at the exterior entrance doors.

- B. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.
- C. Power: Push-button switches shall be powered from their associated controller, using dc control.
- D. Standard device: Stopper Station STI SS2421EM-EN, or CML approved equal.

2.8 WIRELESS PUSH-BUTTON KEY FOB

- A. Wireless Push-Button Key Fob: Black finish, functions with STI receivers.
 - 1. Push-button signals shall report to 911 and to CML Main security control center.
- B. Battery: Energizer A27.
- C. Fob Functions: Alert, or on/off.
- D. Standard device: Stopper Station STI-34106, or CML approved equal.

2.9 DOOR INTERFACE

- A. Exit Device with Alarm: Operation of the exit device shall generate an alarm. Exit device and alarm contacts are specified in Division 8 Section "Door Hardware."
- B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Section 087100 "Door Hardware."
- C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Division 8 Section "Door Hardware."
- D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Division 8 Section "Door Hardware."

2.10 FIELD-PROCESSING SOFTWARE

- A. Operating System:
 - 1. Local processors shall contain an operating system that controls and schedules that local processor's activities in real time.
 - 2. Local processor shall maintain a point database in its memory that includes parameters, constraints, and the latest value or status of all points connected to that local processor.
 - 3. Execution of local processor application programs shall utilize the data in memory resident files.

4. Operating system shall include a real-time clock function that maintains the seconds, minutes, hours, date, and month, including day of the week.
 5. Local processor real-time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds (the time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown).
- B. Startup Software:
1. Causes automatic commencement of operation without human intervention, including startup of all connected I/O functions.
 2. Local processor restart program based on detection of power failure at the local processor shall be included in the local processor software.
 3. Initiates operation of self-test diagnostic routines.
 4. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made.
 5. If the database and application programs are resident, the local processor shall immediately resume operation.
- C. Operating Mode:
1. Local processors shall control and monitor inputs and outputs as specified, independent of communications with the central station or designated workstations.
 2. Alarms, status changes, and other data shall be transmitted to the central station or designated workstations when communications circuits are operable.
 3. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station or designated workstations, shall be stored for later transmission to the central station or designated workstations.
 4. Storage for the latest 4000 events shall be provided at local processors, as a minimum.
 5. Local processors shall accept software downloaded from the central station.
 6. Panel shall support flash ROM technology to accomplish firmware downloads from a central location.
- D. Failure Mode: Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure-mode) state, consistent with the failure modes shown and the associated control device.
- E. Functions:
1. Monitoring of inputs.
 2. Control of outputs.
 3. Reporting of alarms automatically to the central station.
 4. Reporting of sensor and output status to central station upon request.
 5. Maintenance of real time, automatically updated by the central station at least once a day.
 6. Communication with the central station.
 7. Execution of local processor resident programs.
 8. Diagnostics.
 9. Download and upload data to and from the central station.

2.11 FIELD-PROCESSING HARDWARE

A. Alarm Annunciation Local Processor:

1. Respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
3. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
4. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
5. Local processor shall report line supervision alarms to the central station.
6. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 milliseconds.
7. Alarm condition shall be transmitted to the central computer during the next interrogation cycle.
8. Local processor outputs shall reflect the state of commands issued by the central station.
9. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
10. Local processor shall have at least four command outputs.
11. Local processor shall be able to communicate with the central station via TCP/IP as a minimum.

B. Processor Power Supply:

1. Local processor and sensors shall be powered from an uninterruptible power source.
2. Uninterruptible power source shall provide eight hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored.
3. If the facility is without an emergency generator, the uninterruptible power source shall provide 24 hours of battery backup power.
4. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa.
5. Batteries shall be sealed, non-outgassing type.
6. Power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.
7. Loss of primary power shall be reported to the central station as an alarm.

C. Entry-Control Local Processor:

1. Entry-control local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.

3. Entry-control local processor shall provide local entry-control functions including communicating with field devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
4. Processor shall also accept data from entry-control field devices as well as database downloads and updates from the central station that include enrollment and privilege information.
5. Processor shall send indications of successful or failed attempts to use entry-control field devices and shall make comparisons of presented information with stored identification information.
6. Processor shall grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
7. Entry-control local processor shall use inputs from entry-control devices to change modes between access and secure.
8. Local processor shall maintain a date-time- and location-stamped record of each transaction and transmit transaction records to the central station.
9. Processor shall operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the local processor and the central station.
10. Processor shall store a minimum of 4000 transactions during periods of communication loss between the local processor and the central station for subsequent upload to the central station upon restoration of communication.
11. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
12. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
13. Local processor shall report line supervision alarms to the central station.
14. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 ms.
15. Alarm condition shall be transmitted to the central station during the next interrogation cycle.
16. Entry-control local processor shall include the necessary software drivers to communicate with entry-control field devices. Information generated by the entry-control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal.
17. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges.
18. Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time- and location-stamped record of each transaction.
19. Transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
20. Local processor outputs shall reflect the state of commands issued by the central station.
21. Outputs shall be a form C contact and shall include normally open and normally closed contacts.

22. Local processor shall have at least four addressable outputs.
23. The entry-control local processor shall also provide control outputs to portal-control devices.
24. Local processor shall be able to communicate with the central station via TCP/IP as a minimum.

2.12 CABLES

A. Plenum-Type, TIA 232-F Cables:

1. Two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum-foil/polyester-tape shielded pairs with 100 percent shield coverage; plastic jacket.
2. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
3. NFPA 70, Type CMP.
4. Flame Resistance: NFPA 262 flame test.

B. Plenum-Type, TIA 485-A Cables:

1. Two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

C. Multiconductor, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Six conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

D. Paired, Plenum-Type, Lock Cables:

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

E. Paired, Plenum-Type, Lock Cables:

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

F. Paired, Plenum-Type, Input Cables:

1. One pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, aluminum-foil/polyester-tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.
2. NFPA 70, Type CMP.

3. Flame Resistance: NFPA 262 flame test.
 - G. Paired, Plenum-Type, AC Transformer Cables:
 1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
 2. NFPA 70, Type CMP.
 3. Flame Resistance: NFPA 262 flame test.
 - H. LAN Cabling:
 1. Comply with requirements in Division 27 Section "Structured Cabling Systems."
 2. NFPA 262.
- 2.13 TRANSFORMERS
- A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
 1. Record setup data for control station and workstations.
 2. For each Location, record setup of controller features and access requirements.
 3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
 4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
 5. Assign action message names and compose messages.

6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
 7. Prepare and install alarm graphic maps.
 8. Develop user-defined fields.
 9. Develop screen layout formats.
 10. Propose setups for guard tours and key control.
 11. Discuss badge layout options; design badges.
 12. Complete system diagnostics and operation verification.
 13. Prepare a specific plan for system testing, startup, and demonstration.
 14. Develop acceptance test concept and, on approval, develop specifics of the test.
 15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and CAD Technical Drawings in electronic format.
- D. In meetings with A/E and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.3 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Install cables and wiring according to requirements in Division 26 Section "Wires, Cables, and Connectors."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5E rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.
- F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

- A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Install at a maximum distance of 50 ft.
- D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft.
- E. Card Readers and Keypads:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft, and install No. 20 AWG wire if maximum distance is 500 ft.
 - 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
 - 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft.
- G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft.

3.5 GROUNDING

- A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
 - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
 - 2. Bus: Mount on wall of main equipment room with standoff insulators.
 - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

- A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch- (6.4-mm-) high text and symbols as required. Push-button switches shall be connected to the controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.
- B. Install card readers, keypads, push buttons, and biometric readers.

3.7 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Division 26 Section "Identification for Electrical Systems" and with TIA/EIA 606-A.
- B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE AND HARDWARE

- A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 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. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards -

Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.

2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
4. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
 1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 PROTECTION

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system.
- B. Develop separate training modules for the following:
 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.

2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

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SECTION 28 16 00

INTRUSION DETECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Intrusion detection with communication links to perform monitoring, alarm, and control functions.

1.2 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. PIR: Passive infrared.
- C. RFI: Radio-frequency interference.
- D. UPS: Uninterruptible power supply.
- E. Control Unit: System component that monitors inputs and controls outputs through various circuits.
- F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.
- G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.
- H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.
- I. Standard Intruder: A person who weighs 100 lb or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes.
- J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.
- K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

- L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 ACTION SUBMITTALS

- A. Product Data: Components for sensing, detecting, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
 - 1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify control interface devices and media to be used. Describe characteristics of network and other data communication lines.
 - a. Indicate methods used to achieve systems integration.
 - b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
 - c. Describe characteristics of network and other data communication lines.
 - d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
 - 2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
 - 3. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.
 - 4. Master Control-Unit Console Layout: Show required artwork and device identification.
 - 5. Device Address List: Coordinate with final system programming.
 - 6. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
 - 7. Details of surge-protection devices and their installation.
 - 8. Sensor detection patterns and adjustment ranges.
- C. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Samples for Verification: For each type of exposed finish required.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Data for each type of product, including features and operating sequences, both automatic and manual.
 - 2. Master control-unit hardware and software data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
 - 2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.
- E. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.
- F. Comply with NFPA 70.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products by the following:
1. Kantech
 2. Or Owner approved equal

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Description: Hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.
- B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.
1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
 2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
 3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.
- C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.
- D. System Control: Master control unit shall directly monitor intrusion detection devices, and connecting wiring in a multiplexed distributed control system or as part of a network.
- E. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.
- F. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
 2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
 3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
 4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
- G. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.
- H. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:
1. Switch selected lights.
 2. Shift elevator control to a different mode.
 3. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.
- I. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
- J. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.
- K. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.
- L. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.
- M. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.3 SYSTEM COMPONENT REQUIREMENTS

- A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
 - 1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors.
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.
- B. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.
- C. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.
- D. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.
- E. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.
- F. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.
- G. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.
- H. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.4 ENCLOSURES

- A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
- B. Interior Electronics: NEMA 250, Type 12.

- C. Exterior Electronics: NEMA 250, Type 4X
- D. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.5 SECURE AND ACCESS DEVICES

- A. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

2.6 DOOR AND WINDOW SWITCHES

- A. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.
- B. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.
- C. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.
- D. Remote Test: Simulate movement of actuating magnet from master control unit.

2.7 PIR SENSORS

- A. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.
- B. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.
 - 1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet.
 - 2. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree conical.
 - 3. Ceiling-Mounted Unit Pattern Size: 84-inch (2135-mm) diameter at floor level for units mounted 96 inches (2440 mm) above floor; 18-foot (5.5-m) diameter at floor level for units mounted 25 feet (7.6 m) above floor.
- C. Device Performance:
 - 1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F (1 deg C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.
 - 2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.

3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.8 PIEZOELECTRIC-TYPE, GLASS-BREAK SENSORS

- A. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.
- B. Device Performance: Detect unique, high-frequency vibrations caused by breaking glass.
 1. Sensor Element: Piezoelectric crystals in a housing designed to mount directly to glass surface with adhesive provided by element manufacturer. Circular detection pattern, with at least a 60-inch (1525-mm) radius on a continuous glass pane. Sensor element shall not be larger than 4 sq. in. (25.80 sq. cm).
 2. Hookup Cable: Factory installed, not less than 72 inches (1830 mm).
 3. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit.
 4. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
 5. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

2.9 DURESS-ALARM SWITCHES

- A. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.
 1. Minimum Switch Rating: 50,000 operations.
 2. Foot Rail: Foot activated, floor mounting.
 3. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

2.10 MASTER CONTROL UNIT

- A. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.
 1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 2. Include a real-time clock for time annotation of events on the event recorder and printer.
 3. Addressable initiation devices that communicate device identity and status.
 4. Control circuits for operation of mechanical equipment in response to an alarm.

- B. Construction: Freestanding equipment rack, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.
- C. Console Controls and Displays:
- D. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.
- E. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify, with permanent labels, individual components and modules within cabinets.
- F. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.
- D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.
 - 1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Re-inspect after repairs or replacements are made.
 - 2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.
- E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:

1. Electronic door hardware.
2. Network lighting controls.
3. Intercommunications and program systems.
4. Access control.
5. Fire-alarm system.
6. Video surveillance.

3.3 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches the finished floor.

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the Supervising Station.

E. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project.

3.4 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Division 26 Section "Raceways and Fittings." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all

connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120-V Power Wiring: Install according to Division 26 Section "Wire, Cables, and Connectors."
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Division 27 "Structured Cabling Systems".

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

G. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 260553 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from master control unit.

3.6 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 3-ohm ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
 - 1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.
- 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 inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- D. 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.
- E. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
 - 1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
 - 2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."
- F. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."
- G. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

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SECTION 28 20 00

VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.

1.2 DEFINITIONS

- A. AGC: Automatic gain control.
- B. BNC: Bayonet Neill-Concelman - type of connector.
- C. B/W: Black and white.
- D. CCD: Charge-coupled device.
- E. FTP: File transfer protocol.
- F. IP: Internet protocol.
- G. LAN: Local area network.
- H. MPEG: Moving picture experts group.
- I. NTSC: National Television System Committee.
- J. PC: Personal computer.
- K. PTZ: Pan-tilt-zoom.
- L. RAID: Redundant array of independent disks.
- M. TCP: Transmission control protocol - connects hosts on the Internet.
- N. UPS: Uninterruptible power supply.
- O. WAN: Wide area network.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

- B. Shop Drawings: For video surveillance. 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. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
 - 3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
 - 4. Wiring Diagrams: For power, signal, and control wiring.
- C. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for cameras, camera-supporting equipment, 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.
- B. Field quality-control reports.
- C. Product Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 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. Comply with NECA 1.
- C. Comply with NFPA 70.
- D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.2 IP CAMERAS

- A. Fixed Camera
1. The camera shall be of a dome type suitable for internal installation. The camera shall be ivory in appearance.
 2. The network IR camera shall feature up to 5 Mega Pixel resolution in a 16:9 format. 4:3 format shall also be available in smaller resolutions.
 3. The camera should be capable of capturing and transmitting an image size of 1920 x 1080 at 60 images per second.
 4. Focal length of 3.9 – 9.4mm motorized varifocal.
 5. Basis of Design: Hanwha XND-8080RV.
- B. PTZ Camera
1. A 2 MP IP video camera, with multi-streaming (H.265/H.264 and MJPEG) capability and 25x zoom ration in IP66/IK10 rated dome housing.
 2. Video Compression and Transmission – The 2 MP camera shall have the following properties relating to the video signals it produces.
 - a. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously
 - 1) H.265 / H264 – frame rates up to 60 fps
 - 2) MJPEG – frame rates up to 30 fps
 3. The 2 MP camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.

4. Resolution selections
 - a. 1080p (1920 x 1080) Full HD, 720p (1280 x 720) HD
 - b. 1280 x 1024, 1280 x 960, 1024 x 768, 800 x 600, 800 x 448, 720 x 576, 720 x 480, 640 x 480, 640 x 360, 320 x 240
5. Simultaneous unicast access by up to 20 users
6. Multicast or unicast capable
7. Dynamic DNS (DDNS) support
8. 1V peak-peak composite video output signal at camera for setup and diagnostics
9. Camera – The 2 MP camera device shall have the following physical and performance properties:
 - a. Dustproof, waterproof, and IP66 rated.
 - b. True day/night operation with removable IR cut filter
 - c. Low light level operation to 0.05 lux (color) and 0.005 lux (black and white)
 - d. 120 dB multi-exposure Wide Dynamic Range, providing a wide range between dark and light areas visible at the same time
 - e. 2D and 3D digital noise reduction
 - f. Digital zoom
 - g. 32 privacy masking regions utilizing a 4 point quadrangle zone
 - h. Digital image stabilization
10. Intelligence and Analytics – The 2 MP camera shall have a suite of integral intelligent operations and analytic functions to include:
 - a. Motion detection with eight definable detection areas, minimum / maximum object size definition and a learning algorithm that ignores false alarms such as trees and waves on water.
 - b. Detection of logical events of specified conditions from the camera's video input
 - 1) line crossing (passing)
 - 2) appear/disappear
 - 3) audio detection
 - 4) camera tamper (scene change)
 - 5) enter/exit a predefined zone
 - c. Face detection used to create an event whenever there is a face or multiple faces in the image, up to detection of 32 faces simultaneously
 - d. Audio detection above a specified threshold
 - e. Smart Codec operation in which the camera adaptively alters the video compression for a region of interest or a detected face to improve the quality of video in the area specified.
 - f. definable up to 5 regions of interest
11. Interoperability – The 2 MP camera shall be ONVIF Profile S compliant.
12. The 2 MP camera shall possess the following further characteristics:
 - a. Built-in web server, accessed via standard browsers including Google Chrome, MS Edge, Mozilla Firefox & Safari
 - b. Micro SD/SDHC/SDXC memory card and NAS recording options, with configurable pre-alarm and post-alarm recording intervals
 - c. Bi-directional audio
13. Alarms and notifications
 - a. alarm notification triggers:
 - 1) video & audio analytics
 - 2) alarm input (with NW I/O Box)

- 3) network disconnection
- b. available notification means upon trigger:
 - 1) file upload via FTP and e-mail
 - 2) notification via e-mail
 - 3) record to local storage (SD / SDHC / SDXC card)
 - 4) record to network storage
 - 5) PTZ presets
 - 6) external output
- 14. POE capable
- 15. Basis of Design: Hanwha QNP-6230H

2.3 Multi-view Camera

- A. The camera shall provide 360-degree field of view and produce video in quad view mode. It shall also provide digital PTZ along with automated video analytics to allow users to efficiently monitor large visual fields with capability to focus on certain areas when suspicious activity is observed.
- B. Video Compression and Transmission – The multi-directional camera shall have the following properties relating to the video signals it produces.
 - 1. H.265, H.264 and MJPEG compression, each derived from a dedicated encoder and capable of being streamed independently and simultaneously
 - a. H.265 and H.264 – Maximum of 60 fps at all resolutions
 - b. MJPEG – Maximum of 30 fps
 - 2. The multi-directional camera shall be able to configure up to 10 independent video stream profiles with differing encoding, quality, frame rate, resolution, bit rate, and other video settings.
 - 3. The multi-directional camera shall have four lenses and each lens shall provide the following resolutions.
 - a. 1920 x 1080, 1280 x 1024, 1280 x 960, 1280 x 720, 1024 x 768, 800 x 600, 800 x 448, 720 x 576, 720 x 480, 640 x 480, 640 x 360, 320 x 240
 - 4. Simultaneous unicast access by up to 20 users
 - 5. Multicast or unicast capable
 - 6. Dynamic DNS (DDNS) support
 - 7. The multi-directional camera shall provide smart codec (WiseStreamII, Dynamic GOV, and Dynamic fps) to efficiently manage bit rate of the video stream and reduce storage while producing video quality that is visually equal to the one without smart codec.
 - 8. Viewing composition: Quad view
- C. Camera – The multi-directional camera device shall have the following physical and performance properties:
 - 1. IK10 rated for protection against impacts
 - 2. IP66 for protection against dust and water
 - 3. Auto day/night operation with removable IR cut filter
 - a. Low light level operation to 0.05 lux (color) and 0 lux (black and white)
 - 4. 2D and 3D digital noise reduction
 - 5. 32 privacy masking regions utilizing polygons
 - 6. The multi-directional camera shall be able to capture high contrast scenes with 120 dB multi-exposure wide dynamic range.

7. One touch (Simple) or manual focus controllable remotely via network. The camera shall have motorized varifocal lens.
 8. Advanced digital image stabilization with built in gyro sensor. The camera shall be able to measure movements in three axes and accurately enhance images from distortions caused by instability.
- D. Intelligence and Analytics – The multi-directional camera shall have a suite of integral intelligent operations and analytic functions to include:
1. Motion detection with eight definable detection areas, minimum/maximum object size definition and a learning algorithm that ignores false alarms such as trees and waves on water. The camera shall also be able to send meta-data to NVR or VMS to allow users to search for motion events and generate video summary.
 2. Detection of logical events of specified conditions from the camera's video input
 - a. camera tamper (scene change)
 - b. loitering
 - c. directional detection
 - d. defocus detection
 - e. fog detection
 - f. audio detection
 - g. virtual line
 - h. enter/exit
 - i. appear/disappear
- E. Interoperability – The multi-directional camera shall be ONVIF Profile S/T compliant.
- F. The multi-directional camera shall possess the following further characteristics:
1. Built-in web server, accessed via standard browsers including Google Chrome, IE11, MS Edge, Mozilla Firefox, & Apple Safari.
 2. Micro SD/SDHC/SDXC memory card options (4 slot 256 GB each), with configurable pre-alarm and post-alarm recording intervals
 3. Alarms and notifications
 - a. alarm notification triggers:
 - 1) alarm input
 - 2) motion detection
 - 3) video analytics
 - 4) network disconnect
 - b. available notification means upon trigger:
 - 1) file upload via FTP and e-mail
 - 2) notification via e-mail
 - 3) record to local storage (Micro SD/SDHC/SDXC card)
 - 4) external output
 - 5) Pixel Counter available in the plug-in web viewer
 4. Basis of Design: Hanwha PNM-9084RQZ

2.4 CAMERA-SUPPORTING EQUIPMENT

- A. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

- B. Pan-and-Tilt Units: Motorized units arranged to provide remote-controlled aiming of cameras with smooth and silent operation and equipped with matching mounting brackets.
 - 1. Panning Rotation: 0 to 355 degrees, with adjustable stops.
 - 2. Tilt Movement: 90 degrees, plus or minus 5 degrees, with adjustable stops.
 - 3. Speed: 12 degrees per second in both horizontal and vertical planes.
 - 4. Wiring: Factory prewired for camera and zoom lens functions and pan-and-tilt power and control.
 - 5. Built-in encoders or potentiometers for position feedback, and thermostat-controlled heater.
 - 6. Pan-and-tilt unit shall be available with preset positioning capability to recall the position of a specific scene.
- C. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.
- D. Outdoor Protective Housings for Cameras: Aluminum enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.
 - 1. Mechanical (Vandal) Protection: IK10
 - 2. Ingress Protection: IP66
 - 3. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
 - 4. Built-in, thermostat-activated heater and blower units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
 - 5. Sun shield shall not interfere with normal airflow around the housing.
 - 6. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
 - 7. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.

2.5 NETWORK VIDEO RECORDERS

- A. Description: Network Video Recorder
 - 1. Internal minimum 256TB SSD and 24/7 Duty Cycle SATA drives for video storage
 - 2. Solid state hard disk drive for Windows operating system
 - 3. Supports up to 128 4MP IP Cameras
 - 4. 470 Mbps of recording throughput
 - 5. Minimum dual 10Gbps network interfaces
 - 6. Remote monitoring with email/text notification capability
 - 7. Rackmountable, 2 rack unit enclosure
- B. Basis of Design: Wisenet WAVE WRR-P-S206S series

2.6 VIDEO MANAGEMENT SOFTWARE (VMS)

A. Description:

1. The Video Management System (VMS) shall be a software package for comprehensive management of live and recorded video, and associated audio and data.
2. The VMS shall possess the following general characteristics:
 - a. provide effective monitoring of video from IP cameras and encoding devices, two-way audio and data in real time over local and wide area networks
 - b. interactive and multi-level mapping
 - c. data integration from retail and access control systems
 - d. single-screen administration across multiple servers and systems, including:
 - 1) global configuration and monitoring of camera, encoder, and storage settings across the enterprise
 - 2) administration of all users on multiple servers
 - 3) e-mail and text (SMS) notifications
3. automatic identification and IP address assignment of compatible IP cameras and encoders with status display
 - a. The option to enable an embedded DHCP server to assign camera addresses via DHCP.
4. open architecture supporting IP cameras and encoders and access control systems from multiple manufacturers
5. available client software to allow remote access to live and recorded video, including access from mobile devices
 - a. support simultaneous access to video from multiple servers
6. viewing grid functionality
7. provisioned as a service without requiring any application to be running in order to operate
8. 2-way audio support between server, operator, and supported devices.

B. Basis of Design: Wisenet WAVE VMS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN, WAN, and IP network before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

- A. Comply with requirements in Section 270528 "Pathways for Communications Systems."
- B. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- C. For communication wiring, comply with the following:
 - 1. Section 271513 "Communications Copper Horizontal Cabling."

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras level and plumb.
- B. Install cameras with 84-inch minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- C. Set pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms and adjust.
- D. Identify system components, wiring, cabling, and terminals according to Section 270553 "Identification for Communications Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

- a. Prepare equipment list described in "Informational Submittals" Article.
 - b. Verify operation of auto-iris lenses.
 - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
 - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 - e. Set and name all preset positions; consult Owner's personnel.
 - f. Set sensitivity of motion detection.
 - g. Connect and verify responses to alarms.
 - h. Verify operation of control-station equipment.
3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
 4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- E. Video surveillance system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
1. Check cable connections.
 2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
 3. Adjust all preset positions; consult Owner's personnel.
 4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
 5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.

- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

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SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Air-sampling smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Device guards.
8. Magnetic door holders.
9. Remote annunciator.
10. Graphic annunciator.
11. Addressable interface device.
12. Digital alarm communicator transmitter.
13. Radio alarm transmitter.
14. Network communications.

1.2 DEFINITIONS

- A. FACP:** Fire Alarm Control Panel.
- B. NICET:** National Institute for Certification in Engineering Technologies.
- C. PC:** Personal computer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.

3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors according to manufacturer's written recommendations.
 - d. Show air-sampling detector pipe routing.
13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device.

C. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
 - g. Record copy of site-specific software.
 - h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - i. Manufacturer's required maintenance related to system warranty requirements.
 - j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 SPARE PARTS

A. ADDITIONAL INSTALLED DEVICES

1. The Contractor shall include in his bid for the provision and installation of the following additional devices:

a.	Smoke detectors	4
b.	Heat detectors	2
c.	Duct smoke detectors	2
d.	Manual fire alarm box	2
e.	Speaker/Strobe device	4
f.	Strobe device	2
g.	Addressable interface module	4

2. In addition to the above listed devices, the contractor shall include 50'-0" length of conduit and wire for each device, and shall assume that the devices will be installed at the completion of the project as directed by the A/E or Owner. If not all devices are used, the remaining devices shall be turned over to the Owner and any unused amount of labor, conduit and wire shall be credited to the Owner in a deduct change order.

1.7 QUALITY ASSURANCE

- A. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: TWO years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Provide system manufacturer's certification that all components provided have been tested as, and will operate as a system.
- B. Noncoded, UL-listed addressable system, with multiplexed signal transmission with voice enabled speaker and strobe notification.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire Alarm Signal:

1. Fire Alarm signal initiation shall be by one or more of the following devices and/or systems:
 - a. Manual stations.
 - b. Heat detectors.
 - c. Smoke detectors.
 - d. Duct smoke detectors.
 - e. Carbon monoxide detectors.
 - f. Combustible gas detectors.
 - g. Automatic sprinkler system water flow.
 - h. Fire-extinguishing system operation.
2. Fire-alarm signal shall initiate the following actions:
 - a. Continuously operate alarm notification appliances, including voice evacuation notices.
 - b. Identify alarm and specific initiating device at fire-alarm control units and remote annunciators.
 - c. Identify alarm and specific initiating device at connected network control panels and/or off-premises network control panels.
 - d. Transmit an alarm signal to the remote alarm receiving station.
 - e. Unlock electric door locks in designated egress paths.
 - f. Release fire and smoke doors held open by magnetic door holders.
 - g. Activate voice/alarm communication system.
 - h. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - i. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - j. Recall elevators to primary or alternate recall floors.
 - k. Activate elevator power shunt trip.
 - l. Record events in the system memory.
 - m. Indicate device in alarm on the graphic annunciator.

B. Supervisory Signal:

1. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - a. Valve supervisory switch.
 - b. Alert and Action signals of air-sampling detector system.
 - c. Elevator shunt-trip supervision.
 - d. User disabling of zones or individual devices.
 - e. Loss of communication with any panel on the network.
2. System Supervisory signal shall initiate the following actions:
 - a. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
 - b. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

- c. Transmit system status to building management system.
- d. Display system status on graphic annunciator.

C. System Trouble Signal:

1. System trouble signal initiation shall be by one or more of the following devices and actions:
 - a. Open circuits, shorts, and grounds in designated circuits.
 - b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - c. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - d. Loss of primary power at fire-alarm control unit.
 - e. Ground or a single break in internal circuits of fire-alarm control unit.
 - f. Abnormal ac voltage at fire-alarm control unit.
 - g. Break in standby battery circuitry.
 - h. Failure of battery charging.
 - i. Abnormal position of any switch at fire-alarm control unit or annunciator.
 - j. Voice signal amplifier failure.
 - k. Hose cabinet door open.
2. System trouble signal shall initiate the following actions:
 - a. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
 - b. Transmit system status to building management system.
 - c. Display system status on graphic annunciator.

2.3 FIRE-ALARM CONTROL UNIT

- A. Subject to compliance with requirements, provide products by the following manufacturer;
 1. Notifier (no exception)
- B. General Requirements for Fire-Alarm Control Unit:
 1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. The FACP shall be listed for use with supervisory signals from other essential building systems.

- f. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 1. Annunciator and Display: Liquid-crystal type, two line(s) of 40 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
 3. Shall indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 1. Contractor shall verify quantity of each circuit type required with his approved equipment vendor prior to bidding. Fire alarm riser drawings that may be shown on the drawings are intended to be schematic in nature and may not depict all circuits where multiple circuits are required.
 2. Pathway Class Designations: NFPA 72, Class B.
 3. Pathway Survivability: Level 0.
 4. Install no more than 99 addressable devices on each signaling-line circuit.
 5. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station remote station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - c. One USB RS 232 port for PC configuration.
 - d. One RS 232 port for voice evacuation interface.
- E. Smoke-Alarm Verification:
 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
 3. Sound general alarm if the alarm is verified.
 4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

K. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
 - a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."

- d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- L. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters, and digital alarm radio transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Sealed, valve-regulated, recombinant lead acid, Sealed lead calcium.
- N. Surge Suppression: Provide surge suppression devices at each 120V circuit serving fire alarm equipment. Refer to specification section 26 43 13 – Surge Protection for Low Voltage Electrical Power for requirements.
- O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
- P. Manual Fire-Alarm Boxes
1. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - a. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - b. Station Reset: Key- or wrench-operated switch.
 - c. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
 - d. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
- Q. Notification Appliances

1. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - a. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
2. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
 - a. Rated Light Output minimum:
 - 1) 15 cd. in corridors and transition spaces, unless otherwise noted.
 - 2) 30 cd. in other spaces, unless otherwise noted.
 - b. Mounting: Wall mounted unless otherwise indicated.
 - c. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - d. Flashing shall be in a temporal pattern, synchronized with other units.
 - e. Strobe Leads: Factory connected to screw terminals.
 - f. Mounting Faceplate: Factory finished, WHITE.
3. Voice/Tone Notification Appliances:
 - a. Comply with UL 1480.
 - b. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - c. High-Range Units: Rated 2 to 15 W.
 - d. Low-Range Units: Rated 1 to 2 W.
 - e. Mounting: Flush semi-recessed or surface mounted and bidirectional.
 - f. Matching Transformers: Tap range matched to acoustical environment of speaker location.
 - g. Mounting Faceplate: Factory finished, WHITE.

R. Addressable Interface Device

1. General:
 - a. Include address-setting means on the module.
 - b. Store an internal identifying code for control panel use to identify the module type.
 - c. Listed for controlling HVAC fan motor controllers.
2. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
3. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown .
 - a. Allow the control panel to switch the relay contacts on command.
 - b. Have a minimum of two normally open and two normally closed contacts available for field wiring.
4. Control Module:
 - a. Operate notification devices.
 - b. Operate solenoids for use in sprinkler service.

S. System Smoke Detectors

1. General Requirements for System Smoke Detectors:
 - a. Comply with UL 268; operating at 24-V dc, nominal.
 - b. Detectors shall be two-wire type.
 - c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - e. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 1) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - 2) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - 3) Multiple levels of detection sensitivity for each sensor.
 - 4) Sensitivity levels based on time of day.
2. Photoelectric Smoke Detectors:
 - a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
3. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - a. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - b. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
 - c. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 - d. Each sensor shall have multiple levels of detection sensitivity.
 - e. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

- f. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

T. Heat Detectors

- 1. General Requirements for Heat Detectors: Comply with UL 521.
 - a. Temperature sensors shall test for and communicate the sensitivity range of the device.
- 2. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - a. Mounting: Adapter plate for outlet box mounting Twist-lock base interchangeable with smoke-detector bases.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

U. Magnetic Door Holders

- 1. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 - a. Electromagnets: Require no more than 3 W to develop 25-lbf holding force.
 - b. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 - c. Rating: 24-V ac or dc. Rating: 120-V ac.
- 2. Material and Finish: Match door hardware.

V. Graphic Annunciator

- 1. Graphic Annunciator Workstation: PC-based, with fire-alarm annunciator software with historical logging, report generation, and a graphic interface showing all alarm points in the system. PC with operating system software, minimum 500GB hard drive, 19" digital display monitor, with wireless keyboard and mouse.

W. Remote Annunciator

- 1. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - a. Mounting: Flush cabinet, NEMA 250, Type 1.
- 2. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.4 IP/GSM DIGITAL ALARM COMMUNICATOR

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 63 and UL 864.
- B. Basic Performance:
 - 1. The Communicator connect directly to the primary and secondary analog UL Listed Fire Alarm Control Panel telephone ports.
 - 2. The Communicator will communicate to GSM networks in the area including 2G, 3G and 4G. The multi-GSM platform technology automatically detects and chooses the best network in the area based on signal strength and immediately self adjusts for operation.
 - 3. Supports both dynamic (DHCP) or Public and Private Static IP addressing.
 - 4. Communicates over any type of customer-provided Ethernet 10/100 Base network connection (LAN or WAN), DSL modem or cable modem.
 - 5. Data transmits over standard contact-ID protocol is secured with the industry's advanced encryption standard (AES 256 bit).
 - 6. Dual path communications: Uses Internet or GSM as primary.
 - 7. User programmable: 7720P Programming Tool.
 - 8. Diagnostic LEDs: Signal strength and status indications.
 - 9. IP and GSM tested every day.
 - 10. All circuits shall be power-limited, per UL864 requirements
- C. When a fire alarm condition (Alarm, Supervisory or Trouble) is detected, the Fire Alarm Control Panel goes off-hook to dial the central station. The Dialer Capture Module detects the off-hook condition and provides the fire panel with a dial tone. When the fire panel detects the dial tone, it begins dialing the central station. The Dialer Capture Module considers the three second period after dialing as the number dialing has been completed. After the dialing is completed, the Dialer Capture Module returns a handshake to the fire panel. The fire panel then sends the contact ID reports to the Dialer Capture Module, which in turn sends a kiss-off after the report is successfully received from the fire panel. The Dialer Capture Module sends the contact ID reports to the GSM communications module. When all the reports are sent, the fire panel goes on-hook. The GSM communications module then transmits the messages to the central station (either over the internet or the GSM network)..
- D. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- E. Digital data transmission shall include the following:
 - 1. Independent Zone (Alarm, trouble, non-alarm, supervisory)
 - 2. Independent Addressable Device Status
 - 3. AC (Mains) Power Loss
 - 4. Low Battery and Earth Fault
 - 5. System Off Normal

6. 24 Hour Test Signal
7. Abnormal Test Signal (per UL requirements)

- F. Secondary Power: Integral rechargeable battery and automatic charger.
- G. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
- H. Basis of Design: Notifier IPGSM-4G Communicator

2.5 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 1. Factory fabricated and furnished by device manufacturer.
 2. Finish: Paint of color to match the protected device.

2.6 FIRE ALARM CABLE

- A. Furnish only wire recommended by the fire alarm system manufacturer. Coordinate closely with equipment vendor for quantity, type, and size of fire alarm cables required.
- B. SLC Circuit Cable for Addressable Initiation Devices: Power-limited (FPLP) solid or stranded (7 strand minimum) copper, 75 Degrees C insulation, #18 AWG twisted, shielded or unshielded, color-coded vinyl insulation, PVC jacket.
- C. NAC Circuit Cable for Notification Devices: Power-limited (FPLP), solid or stranded (7 strand minimum) copper, 75 Degrees C insulation, #14 AWG twisted, shielded or unshielded, color-coded vinyl insulation, PVC jacket.
- D. All wiring shall be color coded and labeled at each end.
- E. Splicing by way of wire nuts is prohibited. Terminal junction boxes shall be used for wire taps.
- F. All fire alarm wiring shall be plenum rated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
- C. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 - 2. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Smoke- or Heat-Detector Spacing:
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
 - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- G. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

- H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- I. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

3.3 PATHWAYS

- A. Fire alarm cable above ceilings and in non-accessible locations may be routed exposed, where supported by j-hooks or other approved method.
 - 1. Exposed fire alarm cable located less than 96 inches above the floor shall be installed in raceway.
- B. All fire alarm cable shall be installed in raceway.
- C. Exposed fire alarm raceways shall be painted red enamel.

3.4 CONNECTIONS

- A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Electronically locked doors and access gates.
 - 4. Alarm-initiating connection to elevator recall system and components.
 - 5. Supervisory connections at valve supervisory switches.
 - 6. Supervisory connections at elevator shunt-trip breaker.
 - 7. Data communication circuits for connection to building management system.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by the Authority Having Jurisdiction and Owner.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include TWELVE months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for TWO years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within TWO years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11

SECTION 31 00 00

SITE WORK

PART 1 GENERAL

1.01 WORK INCLUDED

- A. These general requirements apply to all sitework operations, including those performed by General, Plumbing, HVAC, and Electrical Contractors. Refer to Division 31 Specification sections for specific general, product and execution requirements.

1.02 RELATED SECTIONS

- A. Site Preparation: Section 31 15 00.
- B. Earthwork: Section 31 30 00.

1.03 QUALITY ASSURANCE

- A. Comply with local, State and Federal requirements regarding materials, methods of work and disposal of excess and waste materials.
- B. Obtain and pay for required inspections, permits and fees.

1.04 PROJECT CONDITIONS

- A. Each Contractor shall locate and identify existing underground and overhead utilities in areas of their sitework.
 - 1. If utilities are to remain, provide adequate means of protection during sitework operations. Repair utilities damaged during sitework operations at responsible Contractor's expense.
- B. When uncharted or incorrectly charted underground piping or other utilities are encountered during sitework operations, notify the Architect immediately for procedure directions.
- C. Locate, protect and maintain benchmarks, monuments, control points, and protect engineering reference points. Reestablish disturbed or destroyed items at responsible Contractor's expense.
- D. Control dust caused by the work. Dampen surfaces as required.
- E. Perform site operations and the removal of debris and waste materials to assure minimum interference with streets, walks, and other adjacent facilities.

- F. Protect and maintain utility services, valves and other services, except items designated for removal.
- G. Mifflin Fire Department will occupy facilities directly across the street from the project site. Perform site work operations to minimize access disruption to the existing fire house and coordinate any disruption with the fire department.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. As selected by Contractor, except as indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Examine the areas and conditions under which sitework is to be performed and materials installed. Do not proceed with the work until unsatisfactory conditions are corrected.
- B. Consult the records and drawings of adjacent work and of existing utilities and their connections which may affect sitework.

END OF SECTION

SECTION 31 15 00
SITE PREPARATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Work Included: Perform site preparation work as shown and specified for all site preparation operations. Work includes:
 - 1. Protecting existing improvements to remain.
 - 2. Removing plants, lawns and vegetation.
 - 3. Removing designated site improvements.
 - 4. Removing debris and waste materials.
 - 5. Stripping topsoil.

1.02 RELATED SECTIONS

- A. Site Work: Section 31 00 00.
- B. Earthwork: Section 31 30 00.
- C. Seeding: Section 32 92 19.

1.03 QUALITY ASSURANCE

- A. Comply with Section 31 00 00 requirements.

1.04 PROJECT CONDITIONS

- A. Perform site preparation work before starting paving operations.
- B. Locate, protect, and maintain active utilities and site improvements to remain.
- C. Provide necessary barricades, coverings and protection to prevent damage to existing improvements indicated to remain.
- D. Restore to original grades and conditions, areas adjacent to site disturbed or damaged as a result of site preparation work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials and equipment: As selected by Contractor, except as indicated.

- B. Tree Protection: Provide one of the following:
 - 1. Wood Rail Fence: 4 x 4 posts; 2 x 4 rails; 4'-0" exposed height above grade.
 - 2. Fabric Fence: 4'-0" high wood slat snow fence fabric or plastic mesh; steel drive posts.

PART 3 EXECUTION

3.01 SITE CLEARANCE AND PROTECTION

- A. Clear and grub areas as required for access to sitework operations and performance of the work.
- B. Remove and dispose of all plants, other vegetation matter and debris from areas to be cleared and grubbed within Contract limits.
 - 1. Use only hand methods for grubbing inside the drip line of trees designated to remain. Strip existing grassplant materials to a maximum depth of 1" under tree canopies and carefully till or scarify existing grade to a maximum depth of 1".
 - 2. Remove stumps to their full depth; remove 3" and larger roots to a depth of 2'-0" below finished grade; and remove 3" and larger roots within 5'-0" of an underground structure, utility line, footings and paved areas.
- C. Care and Removal of Trees: Remove trees within building limits as indicated on the Drawings. Do not remove any other trees without permission of Architect.
- D. Other Improvements: Remove fences and other existing improvements as required to perform the work, and store and maintain for future replacement by Contractor.
- E. Protection Requirements: Protect existing trees indicated to remain in place, against unnecessary cutting, breaking, skinning, or bruising of roots and bark, smothering of trees by stockpiling construction materials or excavated materials within drip line.
 - 1. Protect designated trees to remain with 4'-0" high double wood rail type [or fabric type] fence enclosure. Locate enclosure at drip line of each tree.
 - 2. Erect temporary tree protection fencing before starting site preparation work. Maintain fencing during entire construction period. Remove temporary fencing when no longer needed or when acceptable to the Architect.
 - 3. Water trees and other vegetation as required to maintain their health during the course of construction operations.
 - 4. Interfering branches of trees may be removed, subject to Architect's approval.
 - 5. Contractor is responsible for all damage to plants scheduled to remain. Damage is defined as including the following: removal of tree,

disfigurement of the tree including skinned bark, broken branches or improper pruning and unnecessary compaction of root zone under canopy circumference. Damage that occurs shall be corrected as described below:

- a. Cost for tree replacement shall determined in accordance with the "Guide for Plant Appraisal" by the Council of Tree and Landscape Appraisers (International Society of Arboriculture, Publication #P1209).

F. Topsoil - Stripping and Storage

1. Strip topsoil to its full depth at building areas, and all areas to be regraded or resurfaced.
2. Stop topsoil stripping at trees designated to remain, a sufficient distance to prevent damage to the root system.
3. Dispose of roots, stones and other debris; store topsoil in piles within the work limits.
 - a. Obtain approval of Architect prior to establishing topsoil storage areas.
 - b. Grade and slope stockpiles for proper drainage and to prevent erosion.

3.02 EXISTING UTILITIES

- A. Information on the drawings relating to existing utility services and other structures is from the best sources presently available. All such information is furnished only for information and is not guaranteed. Excavate test pits as required to determine exact locations.
- B. Raise or lower existing catch basins, inlets, manholes and similar structures to accommodate new grade elevations at paved and lawn areas where indicated. Rework structures as required. Reuse existing catch basin, inlet and manhole frames and covers.

3.03 WASTE MATERIALS

- A. Stockpile, haul from site daily and legally dispose of waste materials and debris. Accumulation not permitted.
- B. On-site burning of combustible, cleared materials is not permitted.

3.04 CLEANING

- A. At completion of work, clean site within Contract limits and leave site clear, clean and free of rubbish and debris and suitable for site work operations.

3.05 REPLACEMENT OF MISCELLANEOUS ITEMS

- A. Replace with existing material previously removed and stored.
- B. If damaged, repair to Architect's satisfaction or replace with new material.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Work Included: Provide temporary and permanent erosion and sediment control items as required by governing agency, as required by permit, as indicated on drawings and as specified herein.
- B. Erosion Control on this project is subject to the requirements of Ohio EPA stormwater general permit OHC000006. All contractors and subcontractors performing work on the site are to sign the duty to inform and certification. Contractor will be responsible for any and all fines incurred by the owner due to failure to provide and or maintain the necessary erosion control measures on site.
- C. Contractor is to maintain a copy of the Stormwater Pollution Prevention Plan (SWPPP) and all required logs in the job trailer at all times for the duration of the job. All logs are to be updated as indicated on the plans.

1.02 RELATED SECTIONS

- A. Earthwork: Section 31 30 00.
- B. Seeding: Section 32 92 19.

1.03 SUBMITTALS

- A. Submit material qualification tests and certificates of compliance in accordance with the requirements of the General Conditions and Section 01 33 23.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: See Section 31 30 00.
- B. Hay or Straw Bales: Tightly bound bales of unrotted hay or straw locally available from recent cuttings. Bindings shall be rot resistant string or wire.
- C. Bale Anchors: 1/2" x 3' reinforcing rods or 2" x 2" x 3' wood stakes, 2 per bale.
- D. Filter Barrier Geotextile: Either woven or nonwoven construction and consist of

polypropylene, polyethylene or polyamide fibers or polymeric filaments. Orient filaments or fibers into a stable network enabling them to retain their spacing relative to one another. Provide barrier ultraviolet stabilized and inert to chemicals found in soils.

- E. Filter Barrier Stakes: 2" x 2" x 3' wood stakes.
- F. Riprap Bedding: 1-1/2" stones with maximum of 5% passing No. 4 sieve.
- G. Graded Riprap Stone: Quarried stone of approximate dry density of 165 pounds per cubic foot and the following gradations:

Type	Size - Inches (Square Openings)		
	Maximum	Average (1)	Minimum (2)
R-2	3	1-1/2	1
R-3	6	3	2
R-4 (3)	12	6	3
R-5 (3)	18	9	5

- (1) "Average Size" is that size exceeded by at least 50% of the total weight of the stone placed.
- (2) Pieces smaller than minimum size shown shall not exceed 15% of the total weight of the stone placed.
- (3) 4" bedding layer required.

- H. Seed and Soil Supplements: Provide seed mixture with 20% by weight of perennial ryegrass, 30% red fescue and 50% Kentucky bluegrass. Provide pulverized agricultural limestone and commercial fertilizer 10-20-20 or approved substitute.
- I. Mulch: Unrotted straw free from weeds and course material or other approved product suitable for required application.
- J. Mulch Binder: Cutback or emulsified asphalt or synthetic binder similar to PETROSET, TERRATAACK or AEROSPRAY.
- K. Jute Matting: Cloth or plain weave, undyed and unbleached single jute yarn, 47 to 49" wide, averaging approximately 1 pound per lineal yard, loosely twisted construction (burlap).
- L. Matting Staples: No. 8 plain wire, 6-10" long.
- M. Commercial Matting Products: ERISONET, HOLDGRO, WEEDCHECK, CURLEX. Product must cover minimum of 30% of soil surface.
- N. Sediment Skimmer Assembly: By JW Fairclot or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Install temporary and permanent sediment control items prior to clearing and commencing earthwork or as soon as practical as sitework progresses.
- B. Install required permanent erosion and sediment items as soon as no damage or deterioration will result to those items due to construction activities.
- C. Stabilize by tarping or wetting all exposed earth sufficiently to prevent any blowing of dust or particulates.

3.02 FILTER FABRIC BARRIERS

- A. Construct where indicated or otherwise required by grading operations to reduce sediment runoff including the downstream limits of all disturbances.
- B. Provide height of barrier from 15" to 18".
- C. Provide barrier in continuous roll, cut to barrier length to avoid joints.
- D. Place stakes a maximum of 3' apart at the barrier location; driven securely into ground a minimum of 8".
- E. Excavate a trench approximately 4" wide and 4" deep along the line of stakes and upslope from the barrier.
- F. Staple filter material to wood stakes with wire staples (minimum 1/2" long). Extend 8" of fabric into trench. Do not staple filter material to existing trees.
- G. Backfill and compact trench with excavated material.
- H. If a filter is to be constructed across a ditch line or swale, provide barrier of sufficient length to eliminate end flow. Plan configuration shall resemble an arc or horseshoe with the ends oriented upslope.
- I. Remove filter barrier when upslope area has been permanently stabilized.
- J. Inspect filter barrier immediately after each rainfall and daily during prolonged rainfall. Immediately make required repairs.
- K. Remove and replace damaged or otherwise ineffective filter fabric.
- L. Inspect sediment deposits after each rainfall. Remove deposits when levels reach approximately 1/2 the height of the bales.
- M. Dress to conform to existing grades, prepare and seed sediment deposits remaining after barrier is removed.

3.05 JUTE MATTING

- A. Install on slopes 6:1 or greater abutting pavement and accepting run-off from pavement.
- B. Install per manufacturers instructions. Overlap adjacent sheets and stake at the recommended interval.

3.05 SKIMMER ASSEMBLY

- A. If required to maintain clean site run-off over excavate underground detention excavation as required to provide sediment settling volume
- B. Provide required fittings and adapters to connect to propose headwall or provide a temporary outlet structure.
- C. Install skimmer per J.W. Faircloth instructions.

3.05 MAINTENANCE

- A. Maintain erosion and sediment control items until final project acceptance. Repair breaches and replace deteriorated or missing items immediately upon discovery.
- B. Clean sedimentation basins and catch basins as required to maintain effectiveness or as otherwise directed.
- C. Removal: Remove temporary erosion control items as directed prior to project close-out.

END OF SECTION

SECTION 31 30 00

EARTHWORK

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Requirements of this section apply to all earthwork operations as shown and specified including those performed by General, Plumbing, HVAC and Electrical Contractors. Work includes:

1. Site grading and filling (embankment) to attain proposed grade elevations, profiles and contours.
2. Subgrade preparation for building slabs, pavement, roadways, sidewalks and curbs.
3. Structure excavating and backfilling.
4. Trench excavating and backfilling.
5. Providing granular bedding for water and sewer lines.
6. Providing granular base and fill at interior concrete slabs-on-grade.
7. Providing topsoil and finish grading.
8. Removing surplus, debris and waste materials.
9. Field quality control testing and inspection.
10. Providing granular base for pavement, roadways, sidewalks, curbs and unit pavers.
11. Temporary erosion protection.

- B. Related Work

1. Site preparation: Section 31 15 00.
2. Seeding: Section 32 92 19.
3. Concrete Paving: Section 32 13 13.
4. Erosion and Sediment Control: Section 31 25 00.]

1.02 SUBMITTALS

- A. Submit inspection reports on fill material, subgrade, granular base, foundation excavations, and compaction operations.

1.03 QUALITY ASSURANCE

- A. Comply with Section 02000 requirements.
- B. Perform earthwork in compliance with applicable requirements of governing authorities.

- C. Materials and methods of construction: Comply with City of Columbus Construction and Material Specifications (CCMS), 2018 Edition and as specified.
- D. Testing and Inspection: Performed by a qualified independent testing laboratory, under the supervision of a registered professional engineer, specializing in soils engineering.
 - 1. Provide and pay for soils testing and inspection services during earthwork operations. Testing, inspection service, and Soils Engineer shall be acceptable to the Architect.
- E. Reference Standards
 - 1. ASTM: American Society for Testing and Materials.

1.04 PROJECT CONDITIONS

- A. Protect existing trees, plants, lawns and other features designated to remain as part of the work.
- B. Protect excavations by shoring, bracing, sheeting, underpinning or other methods, as required to prevent cave-ins or loose dirt from entering excavations. Barricade open excavations and post warning lights at work adjacent to public roadways. Conform to Occupational Safety and Health Administration (OSHA), Safety and Health Standards 29 CFR 1926, Subpart P "Excavations, Trenching and Shoring," and all local laws, ordinances and regulations.
- C. Promptly repair damages to adjacent facilities caused by earthwork operations. Cost of repair at responsible Contractor's expense.
- D. Promptly notify Architect of unexpected subsurface conditions. Discontinue work until notification to resume work is provided by the Architect.
- E. Protect bottoms of excavations and soil beneath and around foundations from frost and freezing.
- F. Grade around excavations to prevent surface water draining into excavated areas.
- G. Geotechnical Information: See Section 01 32 00.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All topsoil, fill and backfill material subject to testing and approval. Provide additional imported topsoil and fill as required to complete the work.

B. Backfill and Fill Materials

1. On-site fill: Clean soil or soil-rock mixture free of foreign materials, organic material and debris. Suitable excavated materials removed to accommodate new construction may be used for fill, subject to the Soil Engineer's approval.
2. Imported fill: Clean, natural sandy-clay subsoil or soil-rock mixture, free of foreign matter, organic material, and debris. Designate borrow area. Sample and test as directed by the Geotechnical Engineer.

C. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or crushed sand; capable of specified compaction, and free of organic soil, shale, lumps, or excessive amounts of clay and other foreign substances.

D. Granular Base (Building Porous Fill): Naturally or artificially graded mixture of crushed limestone or gravel, meeting size No. 57 grading requirements of ASTM C33. Surface choke with sand or fines to prevent damage to vapor barrier.

E. Pipe Bedding Material: Crushed stone meeting size No. 57 grading requirements of ASTM D448.

F. Drainage Fill: Washed, uniformly graded mixture of crushed stone, or crushed/uncrushed gravel, having the following gradation:

Sieve Size	Total % Passing
1"	100
3/4"	90 - 100
3/8"	20 - 55
No. 4	0 - 10
No. 8	0 - 5

G. Topsoil: ODOT 653 fertile, friable, natural topsoil of loamy character, free from admixture of subsoil, heavy clay, coarse sand, stones, plants, roots, sticks, and other foreign materials.

1. If the quality or quantity of topsoil stored under Section 31 15 00 is insufficient to complete the work, provide imported topsoil. Obtain rights and pay all costs for imported topsoil material.
2. Proposed topsoil shall be acceptable to Architect and Soils Testing Firm.]

H. Lean Concrete Fill: Minimum 1500 psi, ready mixed. See Section 03 30 00.

I. Erosion Control: Provide for erosion and sedimentation control in accordance with ODOT Construction and Material Specification, Item 207. Erosion methods to consist of straw or hay bales, temporary seeding and mulching or filter fabric as determined by Contractor for conditions encountered. Methods and materials to be

approved by Architect prior to application or use.

1. Erosion Control Fabric (Silt Fence): Synthetic fabric water-permeable filtration separation fabric, nontoxic to plant material, inert to chemicals, and resistant to degradation.
 - a. Fabric: Woven, polypropylene, polyester, polyamide, polyethylene or a combination is acceptable.
 - b. Provide fence fabric with reinforcing cord or similar type method along top edge.
 - c. Fence Height: Approximately 36" high fabric; bury 12" below grade and extend 24" above grade.
 - d. Manufacturer: EXXON GTF-101 System (GTF-180 Fabric) or equal by SUPAC; DuPONT; MONSANTO or STABILENKA.
 - e. Stakes: Provide wood or metal fence stakes (posts) as recommended by fabric manufacturer.
- J. Other materials as required for proper completion of work: As selected by Contractor and approved by Architect.

PART 3 EXECUTION

3.01 GENERAL

- A. Examine areas and conditions under which work is to be performed. Consult the records and drawings of adjacent work and of existing utilities for conditions which may affect the work under this Section.
- B. Establish extent of grading and excavation by area and elevation; designate and identify datum elevation and project engineering reference points. Set required lines, levels, and elevations.
- C. Do not cover or enclose work of this Section before obtaining required inspections, tests, approvals, and location recording.

3.02 EXISTING UTILITIES

- A. Before starting grading and excavating, establish the location and extent of underground utilities in the work area. Exercise care to protect existing utilities during earthwork operations. Perform excavation work near utilities by hand and provide necessary shoring, sheeting and supports as the work progresses.
 1. Locate utilities which require tie-in work before performing work on new utility extension. Verify location and depth of existing utility. Notify Architect of discrepancies in actual field verified inverts and elevations and those indicated on drawings. Do not proceed with utility line work until procedure directions have been obtained from Architect.
- B. Protect active utility services uncovered by excavation.

- C. Notify Architect when interference with existing utility is necessary.
- D. Replace utilities disturbed or destroyed with new materials of same size, quality and dimensions as directed by Architect, at Contractor's expense.
- E. Maintain or permit maintenance of existing overhead, surface, or sub-surface utilities encountered.
- F. Remove abandoned utility service lines from areas of excavation. Cap, plug or seal abandoned lines and identify termination points at grade level with markers.
- G. Accurately locate and record abandoned and active utility lines rerouted or extended on Project Record Documents.

3.03 SITE GRADING

- A. Perform grading within Contract limits and along utility lines, including adjacent transition areas, to new elevations, levels, profiles and contours indicated. Provide subgrade surfaces parallel to finished surface grades. Provide uniform levels and slopes between new elevations and existing grades.
- B. Grading Outside Building Lines: Grade surfaces to assure areas drain away from structures and to prevent ponding and pockets of surface drainage. Provide subgrade surfaces free from irregular surface changes and as follows:
 - 1. Rough grading: Plus or minus 0.20 ft., subgrade tolerance. Degree of finish required will be that ordinarily obtained from either blade-grader or scraper operations.
 - 2. Subgrade surface shall be free of exposed boulders or stones exceeding 4" in greatest dimension in paved areas; 1" in lawn areas.
 - 3. Fill all areas of settlement to proper grade before subsequent construction.
 - 4. Planted areas: Allow for 6" average depth of topsoil at planted areas.
 - 5. Paved areas: Shape surface of subgrade areas to line, grade and cross-section indicated. Provide compacted subgrade suitable to receive paving base materials. Subgrade tolerance plus 1/2", minus 1".
 - 6. Granular base: Grade subgrade surface smooth and even, free of voids to receive granular base materials. Provide compacted subgrade suitable to receive granular base materials. Tolerance 1" in 10'-0".
 - 7. Perform grading, within branch spread of existing trees to remain, by hand methods to elevations indicated. Cut roots cleanly to 3" depth below proposed finished grade. Coat cut roots with tree wound paint.
- C. Grading of Subgrade and Surface of Fill Under Building Slabs
 - 1. Grade subgrade surface smooth and even, free of voids to receive granular base materials. Provide compacted subgrade suitable to receive granular base materials. Tolerance 1" in 10'-0".
 - 2. Grade surface of fill under building slabs smooth and even, free of voids, compacted as specified, and to required elevation.
 - a. Provide final grades within a tolerance of 1" in 10'-0"; the maximum

out-of-level tolerance for the entire length of grade for slabs in either direction shall be plus or minus 2".

3.04 EXCAVATING: GENERAL

- A. Excavate to limits shown on the Drawings, as called for in soils report, and as specified.
- B. Earth excavation shall include the satisfactory removal and disposal of all materials encountered regardless of the nature of the materials, the condition of the materials at the time they were excavated or the manner in which they were excavated, except materials classified as rock excavation.
- C. Storage
 - 1. Store material suitable for backfill adjacent to excavation within work limits shown.
 - 2. Trim neatly, avoid overloading sides of excavation.
 - 3. Do not place on roadways, sidewalks or private property.
- D. Subgrade Remediation
 - 1. Contractor shall review the soils report and follow the report's recommendations for remediation of unsuitable subgrade material. Remediation shall include undercut of existing fill material and replacement with suitable engineered fill.
- E. Unauthorized Excavation consists of removal of materials beyond indicated subgrade elevation or side dimensions without the specific direction of the Architect.
 - 1. Under footings or foundation bases: Unauthorized excavation may be filled by extending the indicated bottom elevation of the footing or base to the excavation bottom without altering the required top elevation. Lean concrete fill (1500 psi minimum) may be used to bring elevations to the proper position. This work can be performed only when acceptable to the Architect and when approval has been given. Architect must be notified and approval given before commencing,
 - 2. Elsewhere: Backfill and compact unauthorized excavations as specified for authorized excavations of the same classification, unless otherwise directed by the Architect.
- F. Shore, sheet or brace excavations as required to maintain them secure; remove shoring as backfilling progresses, when banks are safe against caving.]

3.05 EXCAVATING: STRUCTURE

- A. Conform to the elevations and dimensions indicated on the drawings, within a

tolerance of plus or minus 0.1 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction required, and for inspection.

- B. Preparation for other work: Hand trim foundation excavation to final grade just prior to placing concrete. Remove loose, soft material and all organic matter.
- C. Inspection: Obtain inspection and approval of foundation excavations by Soils Engineering Firm before concrete is placed.
- D. Do not excavate footings or slabs to the full depth when freezing temperatures may be expected, unless footings or slabs are placed immediately after the excavation has been completed. Protect excavation bottoms from freezing if the placing of concrete is delayed.

3.06 EXCAVATING: TRENCH

- A. General
 - 1. Open cut excavations from surface. Under cuts are not permitted.
 - 2. Maintain 5'-0" clear between trench and parallel building footing. When parallel trenches are required to be deeper than footing, maintain a clear distance at least 1-1/2 times the vertical distance below the bottom of the footing or 5'-0", whichever is greater.
- B. Width: Limit to 2'-0" plus the pipe diameter. Maintain excavation walls as near vertical as practical. Provide cribbing and trench wall support required.
- C. Depth
 - 1. Excavate to depths indicated. Provide a minimum of 4'-0" of cover where depths are not indicated.
 - 2. Existing ground elevations shown on the Drawings represent approximated grades at the time the Drawings were prepared.
- D. Bottoming: Provide trench bottom for CCMS Item 603.04 and Item 901.11, Type I pipe bedding.
- E. Tunneling: Not permitted except where shown on the drawings specified herein or authorized in writing by Architect.

3.07 ROCK EXCAVATION

- A. All excavation is unclassified. No additional payment will be made for rock excavation.

3.08 DRAINAGE

- A. Prevent surface water and subsurface or groundwater from flowing into the excavation.
- B. Do not allow water to accumulate in excavations. Remove water from excavations. Provide sumps, pumps, suction and discharge lines and other dewatering system components necessary to convey the water away from the excavations.
- C. All excavation shall be performed under workable dry conditions; prior to any excavation below groundwater level, the dewatering system as shall be installed and placed in operation in order to lower water level below the excavation bottom.
- D. Provide dewatering devices filtered to prevent the removal of fines from the soil.

3.09 PIPE BEDDING

- A. General: Bed all water and sewer lines below slabs-on-grade within building, all sewer lines outside building, except lines requiring concrete encasement. Use bedding material specified herein.
 - 1. Bed pipe in rock excavation in granular backfill material specified herein.
- B. Limits: CCMS Item 901.11, Type 1.
- C. Protection: Carefully place bedding by hand to avoid damage to pipe.
- D. Compaction: Comply with requirements specified herein below.

3.10 FILLING AND BACKFILLING

- A. This Article applies to all filling (embankment) and backfilling operations. Additional requirements for trench backfilling are listed in Article 3.11.
- B. Obtain inspection and approval of subgrade surfaces by Soils Engineer before filling operations. Scarify, dry and compact soft and wet areas; remove and replace unsuitable subgrade materials with compacted fill material as directed.
- C. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below:
 - 1. In all excavations: Excavated or borrow backfill materials.
 - 2. Against face of structure at footing drainage pipes: Drainage fill.
 - 3. Directly under building slabs: Building porous fill; 6" thick unless otherwise indicated.
 - 4. Under walks, steps and pavements: Subbase material.
 - 5. Trenches Containing Underground Pipes/Ducts/Etc: Granular base; extend to minimum 6" above top of duct.
- D. Preparation for Backfill: Backfill excavations as promptly as the Work permits, but

not until completion of the following:

1. Acceptance by Owner of construction below finished grade, including where applicable, dampproofing, waterproofing and perimeter insulation.
2. Inspection, testing, approval and recording locations of underground utilities.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off sheet piling driven below bottom of structures to prevent settlement of the structure or utilities, or leave in place if required.
5. Removal of trash and debris.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
7. Do not backfill against walls until slab on grade and first floor is complete and concrete has attained its design strength.

E. Ground Surface Preparation for Fill

1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills.
2. Slopes Greater Than 4 to 1: Plow, bench, step or break up existing material in such a manner that the embankment material will bond with existing surfaces.
3. Proofroll per "Compaction" Article herein.
4. When the existing ground surface has a density less than that specified under "Compaction" Article herein for the particular area classification, break-up the ground surface, pulverize, moisture-condition to the optimum moisture content, and compact to the required depth and percentage of maximum density.

F. Placement and Compaction

1. Place backfill and fill materials in layers not more than 8" in loose depth.
2. Lift thickness requirements may be modified by Soils Engineer to suit equipment and materials or other conditions when required to assure satisfactory compaction.
3. Moisture-condition fill material by aerating or watering and thoroughly mix materials to obtain moisture content permitting proper compaction.
4. Place and compact each layer of fill to indicated density before placing additional fill material. Repeat filling until proposed grade is attained.
5. Suspend fill operations when satisfactory compaction results cannot be obtained because of environmental or other unsatisfactory site condition. Do not use muddy or frozen fill materials. Do not place fill material on muddy or frozen subgrade surfaces.
6. Maintain surface conditions which permit adequate drainage of rain water and prevent ponding of surface water in pockets. When fill placement is interrupted by rain, remove wet surface materials or aerate and permit to dry before placing additional fill material.
7. Extend fill at buildings a minimum of 5'-0" beyond building foundations,

except as otherwise indicated.

8. Use hand tampers or vibrating compactors at foundation walls. Do not use rolling equipment adjacent to foundation walls.

3.11 TRENCH BACKFILL

- A. Carefully deposit to depth of 12 inches above the top of pipe by methods which will prevent damage or movement of pipe. Deposit backfill in the pipe zone by hand (shovel) for pipe 18 inches and smaller.
- B. Concrete Encasement
 1. Trenches Below Footings: Encase pipe for full width and height of trench, extending 12" beyond each edge of footing.
 2. Trenches where top of pipes are within 2' of driving or parking surfaces: Top of encasement to be minimum 12" above top of pipe.
- C. Granular Backfill
 1. Supply granular backfill for lines located under paved areas.
- D. Backfill only after exact locations and depths of lines and equipment have been recorded and tests and inspections have been completed.

3.12 COMPACTION

- A. Provide compaction control for all fill and backfill. Field compaction tests and related laboratory analysis shall be performed by a qualified independent laboratory, a member of the American Society for Testing and Materials, under the supervision of a registered Professional Engineer specializing in soils engineering. Soils proposed for fill and backfill shall be analyzed by the Soils Engineer.
- B. Perform all compaction work in accordance with ASTM D698 Standard Proctor Method. Percentages of compaction are as follows:
 1. Foundations and Building Slabs: Compact top 12" of subgrade and each layer of fill or backfill to 100% of maximum dry density. Extend compaction at least 5'-0" on both sides of foundation walls and at least 12" beyond slabs-on-grade.
 2. Vehicle Pavement and Roadways: Compact top 12" of subgrade and each layer of fill or backfill to 98% of maximum dry density.
 3. Pedestrian Walks: Compact top 6" of subgrade and each layer of fill or backfill to 95% of maximum dry density.
 - a. Exercise care to obtain proper compaction under edges of walks that abut walls, stairs, curbs, adjacent slabs and other structures.
 4. Lawns and Unpaved Areas: Compact top 6" of subgrade and each layer of fill or backfill material to 90% of maximum dry density.
 5. Compact fill and backfill material for mechanical, plumbing and electrical trenches within building and pavement areas and extending minimum 5'-0" beyond building and pavement areas to 100% of maximum dry density.

- C. Puddling or jetting of fill and backfill materials as a compaction method is not permitted.
- D. Provide adequate equipment to achieve consistent and uniform compaction of fill and backfill materials.
- E. In cut areas, the subgrade surface must meet density criteria equivalent to those specified above for fill layers under various area classifications.
- F. Maintain moisture content of materials, during compaction operations within required moisture range to obtain indicated compaction density.
 - 1. Where the subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to the surface of subgrade, or layer of soil material, to prevent free water appearing on the surface during or subsequent to compaction operations.
 - 2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
 - a. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until the moisture content is reduced to a satisfactory value, as determined by moisture-density relation tests.
- G. Proof Rolling
 - 1. After all topsoil has been removed, those areas receiving fill and those areas that have been cut shall be rolled with a minimum of four overlapping passes of a fully loaded tandem axle dump truck.
 - 2. Unstable material evidenced by the rolling shall be stabilized or removed and replaced with a material complying with backfill and fill material, and compacted accordingly.

3.13 FINISH GRADING

- A. General
 - 1. Finish grade all disturbed areas to blend with surface of adjacent undisturbed areas.
 - 2. Confine work to top 6 inches of backfill.
 - 3. Roll to proper compaction.
- B. Lawn Areas
 - 1. Use stockpile of topsoil previously stored.
 - 2. If supply is not sufficient, obtain additional topsoil from outside source at Contractor's expense.
- C. Placement

1. Do not use frozen or muddy topsoil. Place during dry weather.
2. Fine grade topsoil eliminating rough and low areas to ensure positive drainage. Maintain levels, profiles and contours of subgrades.
3. Remove stones, roots, weeds, and debris while spreading topsoil materials. Provide surfaces suitable for soil preparation provided under lawn work.
4. At trees designated to remain, manually install topsoil not exceeding 2" depth under tree canopies. Avoid damage to root system.

3.14 MAINTENANCE

- A. Protect finish graded areas from traffic and erosion. Keep free of trash and debris. Repair and reestablish grades in settled, eroded and damaged areas.
- B. Where completed areas are disturbed by construction operations or adverse weather, scarify surface, reshape and compact to required density.
- C. Erosion Control: Provide silt fence around all areas where erosion and washing away of soil fines is probable (i.e. areas where existing vegetation has been stripped, earth areas not yet seeded, etc.).
 1. Mound soil approximately 8" to prohibit run-off away from site. Install silt fence on outside face of mounded area. Extend silt fence fabric approximately 12" below grade. Place fence posts and attach fabric to posts at spacing and in a manner approved by fabric manufacturer.
 2. Remove fence as seeding or other type of surface replacement work progresses in a particular area. Do not remove fence where a chance of erosion and run-off exists.
 3. Remove all fence materials at completion of project when directed by Architect.

3.15 WASTE MATERIALS

- A. Stockpile, haul from site and legally dispose of waste materials, including excess excavated materials, rock, trash and debris.
- B. Maintain disposal route clear, clean and free of debris.

3.16 TESTING

- A. Provide field quality control testing and inspection during earthwork operations.
- B. Contractor shall cooperate with, provide access to the work, obtain samples, and assist testing agency and their representatives in execution of their functions.
- C. Foundation excavations: Provide a minimum of two bearing tests. Based on visual examination at the site, provide additional bearing tests as required to verify bearing surfaces are adequate and meet or exceed design bearing values.

- D. Fill material and granular base materials: Test proposed materials to verify suitability for use, gradation of materials, moisture density relation by ASTM D698 Standard Proctor Method and percent of organic materials.
- E. Subgrade surfaces: Based on visual examination at the site, provide bearing tests as required to verify subgrade surfaces are adequate and meet or exceed design bearing values.
 - 1. Structure slabs: Make at least one test for each 2,000 sq. ft. of slab areas.
- F. Compaction operations: Provide full time inspection and testing during building area filling and compaction operations. Test each lift of fill to verify compaction meets specified requirements. Provide periodic inspection and testing during site area filling and compaction operations.
- G. When, during progress of work, field tests indicate that installed compacted materials do not meet specified requirements, provide additional compaction until specified density is achieved, or remove and replace defective materials with new compacted materials as directed by the Architect. Cost of additional labor, materials and testing to attain specified density at Contractor's expense.
- H. Contractor may, at his own option and for his own purpose, make other tests and inspections at the Contractor's expense.
- I. Employment of testing agency shall not relieve the Contractor of his sole responsibility to furnish materials and construction in full compliance with the Contract Documents.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide asphalt paving as indicated and specified. Work includes:

1. Final subgrade preparation and granular base.
2. Asphalt paving.
 - a. Aggregate subbase course.
 - b. Prime coats and tack coats.
 - c. Asphalt intermediate and wearing (finish) courses.
3. Pavement marking.

1.02 RELATED SECTIONS

- A. Site Work: Section 31 00 00.
- B. Earthwork: Section 31 30 00.

1.03 REFERENCES

- A. Materials and Methods of Construction: Comply with City of Columbus "Construction and Material Specifications" (CCMS) 2018 or current edition, and as specified.

1.04 SUBMITTALS

- A. Product Data
1. Submit complete materials list of items proposed for the work.
 2. Submit pavement marking paint and soil sterilizer product data.

1.05 QUALITY ASSURANCE

- A. Tolerances
1. In-Place Compacted Thickness
 - a. Base Course: Maximum 1/2" plus, minus 0".
 - b. Intermediate Course: Maximum 1/4", minus 0".
 - c. Surface Course: Maximum 1/4" plus, minus 0".
 2. Finish Course Smoothness
 - a. Base Course: Maximum 3/8" in 10'-0".
 - b. Intermediate Course: Maximum 1/4" in 10'-0" in any direction.
 - c. Surface Course: Maximum 1/4" in 10'-0" in any direction.

3. Check surface areas at intervals as directed by Architect.
- B. Paving design is based on adequate CBR strength of the subgrade soils. Promptly notify Architect of unsatisfactory subgrade conditions before constructing base course.
- C. Surface Testing
 1. At completion of each section of paving, perform a water test for drainage.
 2. Rework areas where water stands, even to the point of replacement, so that pavement drains as designed. Skin patching for correcting low areas is prohibited.

1.06 PROJECT CONDITIONS

- A. Perform all layout work as required. Take all dimensions and establish elevations.
- B. Subgrade: Rework unsatisfactory subgrade as required.
- C. Weather Limitations
 1. Do not install base course materials over wet or frozen subgrade surface.
 2. Do not apply prime or tack coat material when temperature is below 50 degrees F. Do not apply to wet base surface.
 3. Install asphalt surface material only when base is dry and air temperature is above 40 degrees F.
- D. Safeguards
 1. Maintain vehicular traffic and pedestrian traffic during paving operations, as required for other construction activities.
 2. Provide barricades, warning lights and warning signs for the movement of traffic and safety and to cause the least interruption of work under this Contract.
 3. Protect adjacent work from damage, soiling, and staining during paving operations.

1.07 MAINTENANCE

- A. Repair and/or replace any surface replacement that is damaged due to settlement or inferior materials and workmanship for a period of one (1) year after acceptance of the work by Owner.
- B. Make repairs at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 ASPHALT PAVING

- A. Type: Asphalt paving, aggregate base. Thicknesses as indicated on the

drawings.

1. Aggregate Base: Crushed gravel, Item 304.
2. Prime Coat: Item 408 at .3 to .5 gallons per square yard.
3. Asphalt Intermediate Course: Item 441
4. Asphalt Surface Course: Item 441

2.02 MARKING PAINT

- A. Type: Alkyd or latex.
- B. Color: White
- C. Sheen: Flat
- D. Percent Solids (by weight): 70% to 78%.
- E. Reference
 1. Alkyd: TT-P-115F Type 1.
 2. Latex: TT-P-1952B Type 1.
- F. Drying Items: Under normal field conditions, paint shall be dry to the touch, be free from pickup within 20 minutes, and completely dry within one hour.
- G. Bleeding: Paint shall not bleed or discolor when sprayed on bituminous surfaces.
- H. Manufacturer/Product: PITTSBURGH PAINTS Traffic and Zone Marking #11-3 (white) #11-10 (yellow); SHERWIN WILLIAMS Setfast Acrylic Waterborne Traffic Marking Paint #TM226 (white) #TM225 (yellow); AEXCEL Premium Fast Dry Marking Paint #12W-D272 (white) #12Y-D272 (yellow) or equal.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine subgrade and installation conditions. Do not start asphaltic concrete paving work until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Treat scheduled paved areas subgrade with soil sterilizer herbicide. Apply herbicides in strict accordance with manufacturer's installation instructions and recommended application rates.
- B. Frame Adjustments
 1. Verify frames for manholes, catch basins, and other such units, within areas to be paved, are at their proper elevation. Notify Architect if frames are not at proper heights.

2. Provide temporary closures over openings until completion of rolling operations. Remove closures at completion of the work. Set covers to grade, flush with the surface of adjoining pavement surface.

3.03 APPLICATION

A. Subgrade Preparation

1. Proofroll as specified in Section 31 30 00.
2. Thoroughly compact with 10 ton roller to density specified in Section 02300.
3. Include re-shaping and wetting required along with rolling to obtain proper compaction and the desired cross section.
4. Remove unsuitable material and replace with suitable material as directed by Architect.
5. Compact subgrade at least 18" beyond edge of surface course.

B. Reset castings and other structures to established grade as required.

C. Conform to requirements of various ODOT items specified.

D. Delay application of surface asphalt wearing course until heavy equipment traffic on site has terminated.

3.04 PAVEMENT MARKING

A. Preparation: Surfaces must be dry and free of dirt or loose particles. Remove oil and grease with thinner, recommended by paint manufacturer. Remove loose particles per ODOT 641.

B. Application

1. Comply with ODOT 641. Machine apply at rate to provide 7 to 8 mil dft to define parking stalls, traffic directions, etc.
 - a. Apply material as received from manufacturer without dilution.
 - b. Apply lines 4 inches wide or as indicated on drawings; other markings as indicated.
2. Apply no sooner than 14 days after completion of asphalt concrete paving.
3. Center lines, stop and crosswalk lines, transverse lines, island markings, parking stall lines, lane arrows, and words on pavements: Comply with applicable sections of ODOT 641.08.

C. Protection

1. Keep traffic off of markings until markings are dry.
2. Protect adjacent curbs so that no pavement markings are applied to them. All pavement markings overrunning onto curbs will be removed at Contractor's expense.

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. All exterior concrete paving required or indicated on site plan, including, but not limited to, the following:
 - 1. Curbs, aprons, handicap ramps and pads for equipment and dumpsters.
 - 2. Vehicular paving and sidewalks.
 - 3. Steps.

1.02 RELATED SECTIONS

- A. Asphaltic Concrete Paving: Section 32 12 16.
- B. Cast-In-Place Concrete: Section 03 30 00.
- C. Sealants: Section 07 92 00.

1.03 REFERENCES

- A. American Concrete Institute (ACI)
 - 1. ACI 301 Specifications for Structural Concrete for Buildings
 - 2. ACI 305R Hot Weather Concreting
 - 3. ACI 306R Cold Weather Concreting
 - 4. ACI 316R Recommendations for Construction of Concrete Pavements and Concrete Bases
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C33 Concrete Aggregates
 - 2. ASTM C94 Ready-Mixed Concrete
 - 3. ASTM C143 Slump of Portland Cement Concrete
 - 4. ASTM C150 Portland Cement
 - 5. ASTM C171 Sheet Materials for Curing Concrete.
 - 6. ASTM C185 Welded Steel Wire Fabric for Concrete Reinforcement
 - 7. ASTM C231 Air Content of Freshly Mixed Concrete by the Pressure Method
 - 8. ASTM C260 Air Entraining Admixtures for Concrete
 - 9. ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete
 - 10. ASTM C494 Chemical Admixtures for Concrete

- 11. ASTM D1751 Preformed Expansion Joint Material for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types).

- B. Unless otherwise specified, provide work and materials conforming to ACI 316R.

1.04 SUBMITTALS

- A. Submit in accordance with the General Conditions and Section 01 33 23.
- B. Concrete mix design and test reports specified in Section 03 30 00.

1.05 QUALITY ASSURANCE

- A. Ohio Department of Transportation (ODOT): Construction and Material Specifications, 2019.
- B. Schedule and perform paving work, base course, etc. only after excavation and construction work which might injure them have been completed. Repair damage caused during construction before acceptance of work.
- C. Repair or replace, in accordance with these specifications, existing paved areas damaged or removed during course of this project.
- D. Do not place pavement, base or subbase on a frozen or muddy surface.
- F. Testing
 - 1. Testing and Inspection: Performed by a qualified independent testing laboratory, under the supervision of a registered professional engineer.
 - 2. Provide and pay for testing and inspection services during earthwork operations. Testing and inspection service firm shall be acceptable to the Architect.

PART 2 PRODUCTS

2.01 AGGREGATE BASE

- A. Material: Graded, granular, free-draining material, conforming to ODOT Item 304.

2.02 CONCRETE

- A. Type: Portland cement, air-entrained type.
 - 1. Aggregate (ASTM C33): Limestone.
 - 2. Air Content (ASTM C231): 5% +/- 1% entrained air.
 - 3. Strength: 4000 psi, minimum compressive strength at 28 days with water reducer and air entrainment.
 - a. Water Reducer: Conforming to ASTM C494, as required to

minimize cement and water content of mix at specified slump.

4. Cement: Portland cement, conforming to ASTM C150, Type I or II. Use one color throughout entire project, unless otherwise directed by Architect.
 - a. Content: 600 lbs. per cubic yard, minimum.
5. Water/Cement Ratio: 0.45, maximum.

B. Maximum slump at time of placement (ASTM C143): 2" minimum, 4" maximum.

C. No calcium chloride or admixtures containing calcium chloride are permitted. No admixtures, other than those specified, are permitted without the written permission of the Architect.

2.03 REINFORCING

A. Bars and Welded Wire Fabric: Specified in Section 03 30 00.

1. Welded wire fabric for vehicular traffic to be furnished in flat mats.

2.04 FORMWORK

A. Walks and Steps: Steel or solid lumber, minimum 1-1/2" nominal thickness.

B. Vehicular Traffic: Steel conforming to applicable ODOT Sections.

2.05 ACCESSORIES

A. Expansion Joints

1. Filler: Meet or exceed requirements of ASTM D1751, width as noted under "Joints" herein or indicated on drawings.
2. Joint Cap: Two-piece vinyl device with upper 1/2" removable after curing period; width corresponding to joint filler; products by GREENSTREAK PLASTIC PRODUCTS; VINYLEX CORPORATION or VULCAN METAL PRODUCTS.
3. Sealant: Section 07 92 00.

B. Curing Materials

1. Curing Compound: Resin base, white pigmented compound conforming to ASTM C309, Type 2.
2. Sheet Materials: "Orange Label Sisalkraft" by FORTAFIBER CORPORATION; "Transguard" by REEF INDUSTRIES, INC.; "Poly Burlap" by EAGLE ENCLOSURES or equal material; a non-staining sheet material conforming to ASTM C171. Four mil polyethylene sheeting may be substituted for curing paper.

C. Reinforcing Supports

1. Welded Wire Fabric: "Mesh-Ups" by LOTEL or equal.

2. Bars: Bolsters and chairs suitable for application by DAYTON SURE-GRIP; DURAJoint; BYER STEEL GROUP or equal.

PART 3 EXECUTION

3.01 PREPARATION OF SUBGRADE

- A. Areas to be paved will be compacted and brought to subgrade elevation under Section 02 30 00 before work of this Section is performed. Final fine grading, filling and compaction of areas to receive paving, as required to form a firm, uniform, accurate and unyielding subgrade at required elevations and to required lines shall be done under this Section.
- B. Remove existing subgrade material which will not readily compact as required and replaced with satisfactory materials. Provide additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed in accordance with Section 02 30 00.
- C. Recompect subgrade of areas to be paved as required to bring top 8 inches of material immediately below aggregate base course to the following compactions:
 1. Vehicle Pavement: Compact to 98% of maximum dry density as determined by ASTM D698.
 2. Pedestrian Walks: Compact to 95% of maximum dry density as determined by ASTM D698.
- D. Exercise care to obtain proper compaction under edges of walks that abut walls, stairs, curbs, adjacent slabs and other structures.
- E. Extend subgrade compaction for a distance of at least 1 foot beyond pavement edge.
- F. Areas graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 inches deep in subgrade, shall be graded out, reshaped as required, and recomacted before placing pavement.
- G. Do not store or stockpile materials on subgrade.
- H. Dispose of debris and other material excavated under this Section, and material unsuitable for or in excess of requirements for completing work of this Section off job site.
- I. Obtain Soil Testing and Inspection Firm's inspection and approval prior to installation of gravel base course. See Section 02 30 00. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section.

3.02 AGGREGATE BASE COURSE

- A. Place, spread and compact base course in accordance with ODOT Item 304.

- B. Width of base course shall be greater than or equal to the width of pavement surface, if continuous lateral support is provided during rolling, and shall extend a minimum of 2 times the base thickness beyond edge of pavement if lateral support is not provided.
- C. Place aggregate in maximum lifts of 6" thickness, compacted measure. Compact each lift to specified density.
 - 1. Place material adjacent to wall, manhole, catch basin, and other structures only after such structures have been set to required grade and level.
 - 2. Begin rolling operations at sides and progress to center of crowned areas; begin rolling on low side and progress toward high side of sloped areas. Continue rolling until material does not creep or wave ahead of roller wheels.
 - 3. Replace and properly recompact surface irregularities which exceed 1/2" as measured by means of a 10' long straightedge.
- D. Compact base course as follows:
 - 1. Vehicle Pavement: Compact to 98% of maximum dry density as determined by ASTM D698.
 - 2. Pedestrian Walks: Compact to 95% of maximum dry density as determined by ASTM D698.
- E. Maintain subbase and base course clean and uncontaminated. Mixing of specified base material and less select materials is not permitted. Remove materials spilled outside pavement lines and repair area.
- F. Clean, replace or otherwise repair, to conform to the requirements of this Section, portions of subgrade or of construction above subgrade that become contaminated, softened, or dislodged by passing of traffic or otherwise injured before proceeding with the next operation.

3.03 STEEL REINFORCEMENT

- A. Place reinforcing in accordance with ACI 301.
- B. Thoroughly clean reinforcing of loose mill and rust scale, dirt, ice and other foreign material which may reduce the bond between the concrete and reinforcing.
 - 1. Where there is a delay in placing concrete after reinforcing bars are in place, reinspect and clean reinforcing when necessary.
- C. Do not use reinforcing bars which show cracks after bending.
- D. Unless otherwise indicated on drawings, extend reinforcing to within 2" of formwork and expansion joints. Continue reinforcing through control joints. Lap adjacent sheets of fabric reinforcing 6".

- E. After forms have been coated with form release agent, but before concrete is placed, securely wire reinforcing steel anchors in the exact position indicated, and maintain in that position until concrete is placed and compacted. Provide chair bars and supports in number and arrangement necessary.

3.04 PORTLAND CEMENT CONCRETE PAVING

- A. Paving mix, equipment, methods of mixing and placement, and precautions to be observed as to weather, condition of base, etc. shall meet requirements of ACI 316R.
- B. Notify Architect and Soils Testing and Inspection Firm sufficiently in advance of start of operation to allow for complete preliminary inspection of the work, including base course, forms and reinforcing steel.
- C. Place concrete for full thickness in one operation, without change in proportions; screed to proper elevations; finish and cure as specified. Dusting of surfaces with cement is prohibited.
- D. Follow normal concrete placement procedures. Concrete shall arrive at jobsite so that no additional water will be required to produce specified slump. When conditions develop that require the addition of water to produce the desired slump, permission of the Architect must be obtained.
- E. Do not perform work during rainy weather or when temperature is less than 40 degrees F.
- F. Protect adjacent work from stain and damage during entire operation. Repair or replace damaged and stained areas equal to their original conditions.
- G. When concrete is placed, thoroughly dampen existing concrete, earth, and other water-permeable material against which new concrete is to be placed.
- H. Do not use concrete which has set or partially set before placing. Retempering of concrete will not be permitted.
- I. Thoroughly spade and tamp concrete to secure a solid homogeneous mass, thoroughly worked around reinforcement and into corners of forms.
- J. When joining fresh concrete to concrete that has attained full set, clean set concrete of foreign matter. Remove mortar scum by chipping and washing. Saturate clean, roughened concrete with water; set concrete shall have no free water on surface. Scrub a coat of 1:1 cement-sand grout into dampened concrete. Place new concrete immediately before grout has dried or set.
- K. Construct concrete paving on compacted base accurately formed for required slab thickness and base.
- L. Construction: Concrete installed in the Right of Way shall conform to the applicable

City of Columbus Standard Drawings and Specifications.

- M. Provide concrete curbs and aprons as indicated to conform to details indicated on drawings.

3.05 JOINTS

- A. Location: Locate as indicated on drawings. In absence of information on drawings, provide joints as specified below.
- B. Contraction Joints: Sawed or formed within 8 hours of concrete placement.
 - 1. Slabs
 - a. Space (in feet) between 2 to 2-1/2 times slab thickness (in inches) in both directions (i.e. 4" thick slab, spaces 8' to 10' on centers).
 - b. Grid of control joints to be approximately square with longest side to be not longer than 1.5 times the shortest side.
 - c. Slabs of sufficient thickness to space joints greater than 15 feet require transfer devices; obtain Architect's approval before proceeding.
 - d. Minimum Depth of Joint: 1/4 slab thickness.
 - e. See drawings for joint spacing in sidewalks.
 - 2. Curbs
 - a. Maximum 10 feet on center and aligned with joints in vehicular paving.
 - b. Minimum depth of joint: 1-1/2".
- C. Isolation Joints: Formed prior to concrete placement.
 - 1. Slabs: Provide where slabs abut vertical surfaces, at intersections of sidewalks, or at abrupt changes of width. Include walls, columns, light pole bases, outside face of curbs, and utility structures such as drainage inlets or manholes. Form diamond shape around columns, bases, and round castings.
 - 2. Joint: Full depth of slab; 1/4" joint filler with top flush with slab.
- D. Construction Joints: Provide formed edge cold joint where indicated or required with tooled edge. Construction joints not to occur closer than contraction joint spacing.
- E. Expansion Joints: Formed prior to concrete placement. Provide at building walls, where specifically shown, and when placing concrete during temperatures less than 40 degrees.
 - 1. Slabs
 - a. Space maximum 20 feet on center.
 - b. Provide where slabs abut vertical surfaces, at intersections of

sidewalks, or at abrupt changes of width.

2. Curbs: Align with joints in pavement or in absence of concrete pavement, provide at intervals not to exceed 20 feet.
 3. Sidewalks: See drawings for locations of joints. Provide at all intersections of pavement and vertical surfaces or structures.
 4. Joint: Full depth of slab or curb; 1/2" joint filler with top 3/8" filled with sealant. Sealant installed under Section 07900. Provide removable cap joints for all slabs; set top of cap to finish elevations.
- F. Sealant: All expansion, contraction and construction joints to be sealed under Section 07 92 00.

3.06 STEPS

- A. Formwork: Conform to ACI 347.
- B. Slope treads 1/4" toward nosing; provide nosing with 1" radius; flush riser to be inclined 1" and free from abrupt projections.

3.07 FINISHING

- A. Concrete flatwork surfaces shall be screeded off and finished true to line and grade, and free of hollows and bumps. Surface shall be dense, smooth, and at exact level and slope required.
1. Finished concrete surfaces shall be wood floated and finished with a fine broom to a sandy textured surface. Surface shall not deviate more than 1/8" in 10'.
- B. Unless otherwise indicated, provide exposed horizontal surfaces with a light broom finish, with direction of grooves in concrete surface perpendicular to length of concrete band, slab or pad. After concrete has set sufficiently to prevent coarse aggregate from being torn from surface, but before it has completely set, broom concrete to produce a pattern of small parallel grooves. Provide broomed surface uniform, with no smooth, unduly rough or porous spots or other irregularities. Do not dislodge coarse aggregate during brooming operations.
- C. Immediately following finishing operations, round arises at edges and expansion joints to a 1/4" radius. Score tooled control joints into slab surface with scoring tool. Finish adjacent edges of control joints to a 1/4" radius.

3.08 CURING

- A. It is essential that concrete be kept damp from time of placement until end of specified curing period. It is equally essential that water not be added to surface during floating and troweling operations, and not earlier than 24 hours after concrete placement. Between finishing operations, protect surfaces from rapid drying by a covering of waterproofing paper. Surface shall be damp when covering is placed over it, and shall be kept damp by means of a fog spray of water, applied as often as necessary to prevent drying, but no sooner than 24 hours after placing

concrete. None of the water applied shall be troweled or floated into surface.

- B. Cure concrete surfaces by completely covering with curing paper or by application of curing compound.
 - 1. Waterproof Paper: Completely cover concrete surface. Lap seams and seal with tape. During curing period check surface frequently. Spray with water as often as necessary to prevent drying, but not earlier than 24 hours after placing concrete.
 - 2. Curing Compound: Apply at rate recommended by manufacturer. Apply in two applications perpendicular to each other.
 - 3. Curing Period: Minimum 7 days.

3.09 COLD WEATHER CONCRETING

- A. Heat materials for concrete when concrete is mixed, placed or cured when the mean daily temperature is below 40 degrees F or is expected to fall below 40 degrees F with 72 hours. Protect concrete after placing by covering, heat or both.
- B. Details of handling and protecting concrete during cold weather shall be subject to approval of the Architect. Procedures shall comply with provisions of ACI 306R.

3.10 HOT WEATHER CONCRETING

- A. Protect fresh placed concrete from direct sunshine. Sprinkle forms and reinforcement with cold water just prior to concrete placement. Every effort shall be made to minimize delays which will result in excessive mixing of the concrete after arrival on the job.
- B. During periods of excessive hot weather, 95 degrees F and above, cool concrete ingredients insofar as possible and use cold mixing water to maintain the temperature of concrete at permissible levels all in accordance with the provisions of ACI 305. Concrete with a temperature above 95 degrees F at time of placement will not be acceptable and will be rejected.
- C. Maintain temperature records throughout the period of hot weather giving air temperature, general weather conditions (calm, clear, windy, etc.) and relative humidity. Include checks on temperature of concrete as delivered and after placement. Correlate data with the progress of the work so that conditions surrounding the construction of any part of the work can be ascertained.

3.11 PROTECTION OF CONCRETE SURFACES

- A. Protect concrete surfaces from traffic or damage until surfaces have hardened sufficiently. If necessary, protect exposed surfaces with 1/2" thick plywood sheets.

END OF SECTION

SECTION 32 13 16

DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Walkways.
- B. Related Sections include the following:
 - 1. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

1.03 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.04 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Qualification Data: For manufacturer.
- D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
 - 1. Aggregates.
- E. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials.
 - 2. Admixtures.

3. Curing compounds.
4. Bonding agent or epoxy adhesive.
5. Joint fillers.

F. Field quality-control test reports.

G. Minutes of preinstallation conference.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Comply with Ohio Department of Transportation (ODOT) Construction and Materials Specification (latest edition) as indicated.

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

F. Preliminary samples for review: Provide preliminary sample of seeded aggregate concrete pavement for selection prior to construction of in-place mock-up.

G. Mockups: Cast mockups of full-size sections of concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship as indicated on Drawings.

1. Build mockups of the size as indicated on Drawings and in location as directed by the A/E.
2. Notify the A/E seven days in advance of dates and times when mockups will be constructed.
3. Obtain the A/E's approval of mockups before starting construction.
4. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.
5. Approved mockups may not become part of the completed Work if undisturbed at time of Contract Completion.

- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

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. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.
 - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for curves with a radius 100 feet or less.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.03 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
 - 1. Portland Cement: ASTM C 150, Type I, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C or F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - 2. Blended Hydraulic Cement: ODOT quality, ASTM C 595, Type IS, portland blast-furnace slag; IP, portland-pozzolan; I (PM), pozzolan-modified portland; or I (SM), slag-modified portland cement.
- B. Normal-Weight Aggregates: ODOT Item #304.

- C. Water: ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.04 CURING MATERIALS

- A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- B. Water: Potable.
- C. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
 - 1. Available Products:
 - a. Axim Concrete Technologies; Cimfilm.
 - b. Burke by Edeco; BurkeFilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film.
 - f. Euclid Chemical Company (The); Eucobar.
 - g. Kaufman Products, Inc.; Vapor Aid.
 - h. Lambert Corporation; Lambco Skin.
 - i. L&M Construction Chemicals, Inc.; E-Con.
 - j. MBT Protection and Repair, ChemRex Inc.; Confilm.
 - k. Meadows, W. R., Inc.; Sealtight Evapre.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. Symons Corporation; Finishing Aid.
 - p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
- D. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
 - 1. Available Products:
 - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. Burke by Edoko; Aqua Resin Cure.
 - c. ChemMasters; Safe-Cure Clear.

- d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
- e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
- f. Euclid Chemical Company (The); Kurez DR VOX.
- g. Kaufman Products, Inc.; Thinfilm 420.
- h. Lambert Corporation; Aqua Kure-Clear.
- i. L&M Construction Chemicals, Inc.; L&M Cure R.
- j. Meadows, W. R., Inc.; 1100 Clear.
- k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
- l. Symons Corporation; Resi-Chem Clear.
- m. Tamms Industries Inc.; Horncure WB 30.
- n. Unitex; Hydro Cure 309.
- o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.05 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:
 - 1. Types I and II, non-load bearing or IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Chemical Surface Retarder: Water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
 - 1. Available Products:
 - a. Burke by Edeco; True Etch Surface Retarder.
 - b. ChemMasters; Exposee.
 - c. Conspec Marketing & Manufacturing Co., Inc.; Delay S.
 - d. Euclid Chemical Company (The); Surface Retarder S.
 - e. Kaufman Products, Inc.; Expose.
 - f. Metalcrete Industries; Surfard.
 - g. Nox-Crete Products Group, Kinsman Corporation; Crete-Nox TA.
 - h. Scofield, L. M. Company; Lithotex.
 - i. Sika Corporation, Inc.; Rugasol-S.
 - j. Vexcon Chemicals, Inc.; Certi-Vex Envioset.

2.06 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
 1. Compressive Strength (28 Days): 4000 psi.
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 3. Slump Limit: 5 inches, plus or minus 1 inch.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
 2. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
 3. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
 1. Fly Ash or Pozzolan: 25 percent.
 2. Ground Granulated Blast-Furnace Slag: 50 percent.
 3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.07 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
 1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.02 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
 - 1. Butt Joints: Use bonding agent or epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate expansion joints as indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 5. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
- E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.05 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site.
- F. Do not add water to fresh concrete after testing.
- G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating joint devices.
- I. Screed pavement surfaces with a straightedge and strike off.

- J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- K. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
- L. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.06 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture at locations indicated.

3.07 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during

finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 - 1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.08 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 - 1. Elevation: 1/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot- long, unlevelled straightedge not to exceed 1/4 inch.
 - 4. Joint Spacing: 3 inches.
 - 5. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 6. Joint Width: Plus 1/8 inch, no minus.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency provided by the A/E.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to the A/E, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the A/E but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the A/E.
- G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- 3.10 REPAIRS AND PROTECTION
- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.
- B. Drill test cores, where directed by the A/E, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Expansion and contraction joints within cement concrete pavement.
- B. Related Sections include the following:
 - 1. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.03 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- D. Qualification Data: For Installer.
- E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the commencement of the Work.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
 - 2. When joint substrates are wet or covered with frost.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by the A/E from manufacturer's full range.

2.03 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
 - 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. Crafcro Inc., an ERGON company; RoadSaver Silicone.
 - b. Dow Corning Corporation; 888.
 - c. Pecora Corporation; 301 NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
 - 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. Crafcro Inc., an ERGON company; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Pecora Corporation; 300 SL.

2.04 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.05 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses provided for each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealants from surfaces adjacent to joint.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.04 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Contract Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION

SECTION 32 14 00

UNIT PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Stone pavers.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete base under unit pavers.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:** Conduct conference at Project site.

1.03 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:
 - a. Pavers.
 - b. Mortar and grout materials.

- B. Sieve Analyses:** For aggregate setting-bed materials, according to ASTM C136.

- C. Samples for Verification:** For full-size units of each type of unit paver indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints. Include Samples of the following:

1. Joint materials.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data:** For Installer.

- B. Adhesion and Compatibility Test Reports:** From latex-additive manufacturer for mortar and grout containing latex additives.

- C. Material Certificates:** For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

- 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified unit paving installer. Installer's field supervisor must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with the following designations:

- 1. Commercial Paver Technician Designation.

- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

- 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

- 1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

- D. Store liquids in tightly closed containers protected from freezing.

- E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.08 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.
 - a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.02 STONE PAVERS

- A. Limestone Pavers: Irregular flagstone paving slabs made from limestone complying with ASTM C568/C568M.
1. Ottawa Buff Rustic irregular flagging supplied by Lang Stone (614) 228-5489, or approved equal.
 2. Finish: Natural cleft.
 3. Thickness: Not less than 1-1/2 inches nominal unless otherwise indicated.

2.03 ACCESSORIES

- A. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.04 MORTAR SETTING-BED MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Sand: ASTM C144.
- D. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
- E. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.
1. Provide product that is approved by manufacturer for application thickness of 5/8 inch.

- F. Water: Potable.

2.05 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, made of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Standard Cement Grout: ANSI A118.6, sanded.
- C. Grout Colors: As selected by Architect from manufacturer's full range.
- D. Water: Potable.

2.06 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.
- B. Mortar-Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.
- C. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.
- D. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.
- E. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.
 - 1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.
 - 2. Colored-Aggregate Grout: Produce color required by combining colored aggregates with portland cement of selected color.
- F. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

3.03 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Joint Pattern: As indicated.
- E. Tolerances:
 - 1. Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- F. Expansion and Control Joints:
 - 1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints. Install joint filler before setting pavers.

3.04 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

- C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
- E. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch-thick bond coat to mortar bed or to back of each paver with a flat trowel.
- F. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
- G. Spaced Joint Widths: Provide 3/4-inch nominal joint width with variations not exceeding plus or minus 3/16 inch.
- H. Grouted Joints: Grout paver joints complying with ANSI A108.10.
- I. Grout joints as soon as possible after initial set of setting bed.
 - 1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
 - 2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
 - 3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
 - 4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
- J. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.05 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION

SECTION 32 17 26

DETECTABLE WARNING TILES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Cast iron detectable warning plates for pedestrian walking surfaces.

1.03 REFERENCE STANDARDS

- A. ADAAG for Accessible Public Design Rights-of-Way, Section R304.
- B. AASHTO M 333.
- C. ASTM A48 Class 35B and/or AASHTO M 105
- D. ASTM A 536 All Grades or ASTM A 536 Ductile Iron
- E. ISO 9001:2015

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years documented experience.
- B. System of manufacturing quality assurance must conform to the requirements of ISO 9001:2015 and be certified by a third party.
- C. Castings shall be of uniform quality, free from sand holes, gas holes, cracks, shrinkage and other surface defects. Castings shall be reasonably well cleaned by shot blasting. Runners, risers, fins and other cast-on pieces shall be removed from the castings and such areas shall be ground smooth. As-cast dimensions may vary within accepted foundry tolerances as outlined in the Iron Castings Handbook published by the American Foundrymen's Society, Inc. Nominally, casting dimensional tolerances shall be +/- 1/16 inch per foot.

1.05 WARRANTY

- A. Provide manufacturer's standard ten-year warranty against manufacturing defects, breakage or deformation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Cast Iron Detectable Warning Plates:

1. EJ Group, Inc.: www.ejco.com

2.02 TACTILE AND DETECTABLE WARNING DEVICES

A. Cast Iron Detectable Warning Plates:

1. Material: Gray Iron ASTM A 48 Class 35 B and/or AASHTO M 105, Class 35B gray iron and/or ASTM A 536 Ductile Iron. Castings must contain a minimum of 85% recycled content.
2. Markings: All detectable warning plates shall have the product name or series number (example: manufacturer's logo), country of origin and the manufactures identification or name permanently cast on the top surface. The bottom of the casting shall have the approved part number and production date (example: mm/dd/yy) for tracking purposes.
3. Installation Markings: Cast in place. All DWP must have an integral iron anchor tab to ensure proper restraint in the concrete slab.
4. Shape: Square, 24"x24".
5. Pattern: Truncated domes in compliance with ADA Standards
6. Joint: Square and Rectangular Plates will be provided with optional bolting for assurance of proper dome spacing during installation. Interlocking plates include built-in, quick connectors and do not require bolts.
7. Product: EJ DURALAST Detectable Warning Plate:
 - a. Finish: Asphalt Coating

PART 3 - EXECUTION (not used)

END OF SECTION

SECTION 32 33 00

SITE FURNISHINGS

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. Bike rack.
 - 2. Litter/recycling receptacle.
 - 3. Smoking receptacle.
 - 4. Bollard.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For site furnishings.

1.04 QUALITY ASSURANCE

- A. Installer and Fabricator Qualifications: Workmanship shall be best standard practice of trades and shall be performed by mechanics skilled in the type of Work required.
- B. Regulatory Requirements: Meet requirements of applicable laws, codes, and regulations required by authorities having jurisdiction over Work.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area in accordance with manufacturer's original, unopened containers and packaging until installation.
- C. Handling: Protect materials and finish during handling and installation to prevent damage.

1.06 WARRANTY

- A. Products will be free from defects in material and/or workmanship for a period of three years from the date of invoice.
 - 1. Warranty does not apply to damage resulting from accident, alteration, misuse, tampering, negligence, or abuse.
 - a. Scratches, nicks and dents are to be considered normal wear and tear and are not covered by the warranty.
 - 2. Manufacturer shall, at its option, repair, replace, or refund the purchase price of any items found defective upon inspection by the manufacturer's authorized service representative.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 BIKE RACK

- A. Basis of Design Product: Inverted "U" type bike rack (U190) manufactured by MADRAX, www.madrax.com, Contact: Angie Smith, Spruce and Gander, angie@spruceandgander.com, (330) 460-5892.
 - 1. Material: Stainless Steel
 - 2. Surface mount to concrete pavement

2.02 LITTER / RECYCLING RECEPTACLE

- A. Basis of Design Product: Witt Stadium Series Standard 55 gallon (55SC55-01) with lid (SC55HT), manufactured by ANOVA Furnishings, www.anovafurnishings.com, Chase Allman, (614) 581-6399
 - 1. Color: Stainless Steel.
 - 2. Surface mount to concrete pavement.

2.03 SMOKING RECEPTACLE

- A. Basis of Design Product: Rubbermaid item #4HGV7, model #FGR93400SM.
 - 1. Color: stainless.

2.04 BOLLARD

- A. Basis of Design Product: Shaw Stainless LLC, which is located at: 3275 Florence Rd.; Powder Springs, GA 30127; Toll Free Tel: 800-282-9694; Tel: 678-290-9211; Email: [request info \(rob@shawfab.com\)](mailto:request%20info%20(rob@shawfab.com)); Web: <https://stainlessandalloy.com>
 - 1. Compliance: Welding conforms with AWS D1.1 standard.
 - 2. Materials: Type 316/316L stainless steel.

- a. Finish: No. 4 circumferential brush finish.
- 3. Bollard Tops: Flat.
- 4. Bollard Height Above Grade: 36 inches (914 mm).
- 5. Outer Dimensions: 6-5/8 inches (168 mm), fits up to nominal 4 inch pipe bollard.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

3.03 PROTECTION

- A. Apply protective coverings to prevent damage until date of final completion.

END OF SECTION

SECTION 32 84 00

PLANTING IRRIGATION

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. Piping.
 - 2. Sleeving for piping.
 - 3. Automatic control valves.
 - 4. Miscellaneous piping specialties.
 - 5. Sprinklers
 - 6. Quick couplers.
 - 7. Drip irrigation specialties.
 - 8. Controllers.
 - 9. Boxes for automatic control valves.

1.03 DEFINITIONS

- A. Circuit Piping: Downstream from control valves to sprinklers during flow.
- B. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
- C. 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.

1.04 PERFORMANCE

- A. Irrigation zone control shall be automatic operation with controller and automatic control valves.
- B. Location of Sprinklers and Specialties: Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.
- C. This work includes all required permits and inspections. All plumbing and electrical work must comply with all local building code requirements. All associated interior and exterior plumbing and electrical work, including controller connections, must be finished to complete the system.

- D. Contractor to include one (1) full day to review the operation of the irrigation system with the Owner's Representative once the system is one hundred percent (100%) operational.

1.05 SUBMITTALS

- A. Product Data: Submit electronic copies of manufacturer's product data and installation instructions for each of the system components including all sprinkler heads, automatic valves, controllers, and quick coupling valves to be used on the project.
- B. Shop Drawings: Submit to the Owner drawings showing all deviations from the plans, including layout of piping, heads, valves, zones, control systems, and wiring prior to installation.
- C. Qualification Data: For qualified Installer.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Minimum of five (5) years experience installing underground irrigation systems of comparable size. All work to be performed under the supervision of a qualified superintendent.
- B. Obtain Owner's Representative's acceptance of installed and tested underground sprinkler system before installing backfill materials.
- C. Construct the system to grade and in conformance to all areas and locations designated on the drawings.
- ~~D.~~ Irrigation products listed as a specific manufacturer's product are intended to establish the level All of quality and significant characteristics for the purposes of evaluating comparable products. The substitution of comparable products shall comply with Division 01 section "Substitution Requirements" and with the Division 00 Standard Subcontract Form.
- E. Coordinate this work with that of all other trades on the Project.
- F. 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.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all system components in manufacturer's original undamaged and unopened containers with labels intact and legible.
- B. Provide secure locked storage for valves, sprinkler heads and similar components that cannot be immediately replaced to prevent installation delays.
- C. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
- B. PE Pipe: ASTM D2239, SDR 11.5, PE23 rated at 100 psi, NSF approved. Polyethylene pipe is not to be used.
- C. PVC Pipe, Mainline: PVC pipe three (3") inch in diameter and larger shall be SDR 21 Class 200 PVC ring-tite (gasket) pipe.
 - 1. Fittings: Ductile iron fittings with gasket joints required on 3" or larger mainline. Use Harco or approved equal.
- D. PVC Pipe, Laterals: PVC pipe two and one-half (2 ½") inches in diameter and smaller shall be SDR 21, Class 200 PVC solvent weld.
 - 1. Fittings: Schedule 40 PVC, ASTM D2466 molded fittings suitable for solvent weld.

2.02 PIPING JOINING MATERIALS

- A. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656. Primer to be purple in color. Solvent to be appropriate for pipe and fitting type and weather conditions.
- B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.03 AUTOMATIC CONTROL VALVES & MASTER VALVE

- A. Plastic, Automatic Control Valves:
 - 1. Manufacturers: Rain Bird PGA Series Valves
 - 2. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

2.04 SPRINKLERS

- A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure. See drawing legend for each type required.
 - 1. Rain Bird RD Series Spray Heads
 - 2. Rain Bird RD-SAM-P45
 - 3. Rain Bird 5004-PC/FC-R

2.05 QUICK COUPLERS

- A. Manufacturers: Rain Bird 5LRC
 - 1. Install per Detail, in minimum 10" valve box.
 - 2. Provide (1) Quick Coupler Key & (1) hose swivel

2.06 ISOLATION VALVES

- A. Manufacturers: Nibco
 - 1. Nibco T-113K
 - 2. Install valve in minimum 10" valve box.

2.07 CONTROLLERS

- A. Manufacturers: Rain Bird ESP-LXD
 - 1. Wiring: Rain Bird Maxi Cable
 - a. Splicing Materials: Low voltage wire connectors to be made using wire nuts and 3M DBY/DBR connectors or equal; suitable for direct burial. One hundred and twenty (120) volt or heavier splices made underground to use wire nuts and 3M brand DBY. All splice materials must meet Rain Bird Specifications for Decoder Systems. Non-compliant splice kits will not be accepted.
 - b. Irrigation control wire on the interior to be installed thru Electrical Conduit to the exterior at all (3) Irrigation Connection water stub-out locations.
 - c. All splices must be contained within a valve box, minimum of 10" round. Record splice locations on required as-built drawings.
 - d. Surge Protection: Install Rain Bird LSP-1Turf Surge protection as shown. If installation of mainline/valves change, the Contractor is responsible for locating additional surge protection to meet Rain Bird surge requirements.

2.08 BOXES FOR AUTOMATIC CONTROL VALVES

- A. Plastic Boxes:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
 - a. Carson Industries LLC
 - b. Rain Bird Corp.
 - 2. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
 - a. Size: Single valves shall be installed using a ten (10) inch round box. Two valves shall be installed using an eighteen (18) inch by twelve (12) inch rectangular box. Three valves shall be installed using a Jumbo Valve box.
- B. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4 inch minimum to 3 inches maximum.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Examine final grades and installation conditions. Do not start underground sprinkler system work until finished grades are established and unsatisfactory conditions have been corrected.
- B. Layout and stake the location of each pipe runs and all sprinkler heads and sprinkler valves. Obtain Owner's Representative's acceptance of layout before excavating.

3.02 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."
- B. Excavating shall be considered unclassified and shall include all materials encountered, except materials that cannot be excavated by normal mechanical means. Excavate trenches of sufficient depth and width to permit proper handling and installation of pipe and fittings. Excavate to depths required to provide two (2") inch depth of earth fill or sand bedding for piping when rock or other unsuitable bearing material is encountered.
- C. All mainline and continuously pressurized pipe is to be installed using open trenches. Lateral pipe may be installed by "plowing" if soil conditions permit and soils do not contain gravel, rock, construction debris or other potentially damaging material.
- D. The top ten (10") inches of backfill shall be topsoil, free of rocks, subsoil or trash. Any special soil mixture shall be replaced to the original condition it was prior to irrigation installation.
- E. Fill to within six (6") inches of final grade with approved excavated or borrows fill materials free of lumps or rocks larger than two (2") inches in any dimension.
- F. Fill to match adjacent grade elevation with approved earth fill material. Place and compact fill in layers not greater than eight (8") inches in depth.

3.03 PIPING INSTALLATION

- A. All mainline and contiguously pressurized pipes are to be installed using open trenches.
- B. Install PVC piping in dry weather when temperature is above 40 degrees Fahrenheit. Allow glued joints to set at least twenty-four (24) hours at temperatures above 40 degrees Fahrenheit before pressure is applied to the system.
- C. Store pipe such that it is protected from oil and grease and from prolonged exposure to sunlight and excessive heat.
- D. Minimum depth of cover over lateral pipe shall be twelve (12") inches and over mainline pipe shall be eighteen (18") inches.
- E. Install plastic pipe in accordance with manufacturer's installation instructions.

- F. Where mainline pipe crosses piping related to the subgrade system drainage, the mainline piping shall go over the subgrade drainage, provided the mainline pipe is not installed with less than eighteen (18") inches of cover.
- G. Install piping in sleeves under parking lots, roadways, and sidewalks.
- H. Install sleeves made of ASTM D 2241, Schedule 40 PVC pipe and socket fittings, and solvent-cemented joints. Minimum size of sleeves to be three (3) inches; all sleeves shall be minimum of two times the size of the pipe being sleeved.

3.04 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. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.
- D. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

3.05 VALVE INSTALLATION

- A. Electric valve installation shall be as indicated on the drawings. All electrical and manual valves shall be enclosed in a minimum ten (10") inch width valve box. Add extensions as required to prevent soil settlement around the valve. Set box flush with finish grade and aligned with adjacent boxes and/or adjoining site work.
- B. Install valve access boxes on a suitable base of gravel to provide a level foundation at proper grade and to provide drainage of the access box. Support box with block or notch box to protect pipe under box.

3.06 SPRINKLER INSTALLATION

- A. Install fittings and sprinkler heads in accordance with manufacturer's instructions, except as otherwise indicated.
- B. Provide pop-up spray heads and three-quarter (3/4") inch with the "funny pipe" flexible swing pipe or equivalent.
- C. Provide all quick coupling valves and one (1") inch IPS sprinklers with three (3) elbow swing joints. Use Lasco one (1") pre-fabricated 'O' Ring joints as detailed on the drawings.

- D. Set sprinkler heads perpendicular to finished grades, except as otherwise indicated and positioned to prevent contact with grounds maintenance equipment. Locate sprinkler heads to assure proper coverage of indicated areas. Do not exceed sprinkler head spacing distances indicated.

3.07 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

- A. Equipment Mounting: Install controller as directed, location approved by General Contractor.
 - 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Install control cable in same trench as irrigation piping and at least 2 inches below or beside piping. Provide conductors of size not smaller than recommended by controller manufacturer.

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Flushing and Testing:
 - 1. The sprinkler main shall be tested under normal water pressure for a period of twelve (12) hours.
 - 2. If leaks occur, repair and repeat the test. Give the Owner's Representative twenty-four (24) hours notice prior to testing.
 - 3. Adjustment of the sprinkler heads and automatic equipment shall be done by the contractor upon completion of installation to provide optimum performance. The contractor shall make minor adjustment during the guarantee period.
 - 4. After all new sprinkler piping are in place and connected for a given section and all necessary division work has been completed, and prior to the installation of sprinkler heads, all control valves shall be opened and a full head of water used to flush out the system.
 - 5. Testing of the system shall be performed after completion of each section or completion of the entire installation. Any necessary repairs shall be made, at the contractor's expense, to put the system in good working order before the owner shall make final payment.

3.09 STARTUP SERVICE

- A. Irrigation contractor to perform (1) Spring startup and (1) Fall winterization service.

3.10 GUARANTEE

- A. Guarantee underground sprinkler system against defects in workmanship and materials for one (1) year from date of substantial completion.

- B. Guarantee includes contractor returning to the site for Fall winterization and Spring start-up service.
- C. Guarantee that all trenches and other disturbed areas shall be free from heaving and/or settling by more than one-quarter (1/4"). If necessary, adjust the grade, re-grade the trench, and re-seed. This no settlement guarantee shall extend over the entire one-(1) year guarantee from date of acceptance.

3.11 CLEANING

- A. Flush dirt and debris from piping before installing sprinklers and other devices.

END OF SECTION

SECTION 32 91 13

SOIL PREPARATION

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 planting soils specified by composition of the mixes.
- B. Related Requirements:
 - 1. Section 329200 "Turf and Grasses" for planting soil for lawns.
 - 2. Section 329300 "Plants" for planting soil for plantings.

1.03 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.
- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
- H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

- J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- M. SSSA: Soil Science Society of America.
- N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- Q. USCC: U.S. Composting Council.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Include sieve analyses for aggregate materials.
 - 4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
 - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- B. Samples: For each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- C. Field quality-control reports.

1.07 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.08 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.

1.09 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:
 - 1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
 - 2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 - 3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
 - 4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D698 (Standard Proctor).
- C. Chemical Testing:
 - 1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
 - 2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."

3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
 4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.
- D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT NCR-13, SSSA NAPT NEC-67, SSSA NAPT SERA-6 or SSSA NAPT WERA-103, including the following:
1. Percentage of organic matter.
 2. CEC, calcium percent of CEC, and magnesium percent of CEC.
 3. Soil reaction (acidity/alkalinity pH value).
 4. Buffered acidity or alkalinity.
 5. Nitrogen ppm.
 6. Phosphorous ppm.
 7. Potassium ppm.
 8. Manganese ppm.
 9. Manganese-availability ppm.
 10. Zinc ppm.
 11. Zinc availability ppm.
 12. Copper ppm.
 13. Sodium ppm.
 14. Soluble-salts ppm.
 15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 16. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inchdepth of soil.
 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inchdepth of soil.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Do not move or handle materials when they are wet or frozen.
 - 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.01 PLANTING SOILS SPECIFIED BY COMPOSITION

- A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.
- B. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Blend existing, on-site surface soil as recommended in the soils report.
- C. Imported Planting-Soil Type Topsoil:
 - 1. Kurtz Brothers Professional Blend, manufactured by Kurtz Brothers, Columbus OH (614) 289-6102, or approved equal.

2.02 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Provide lime in form of ground dolomitic limestone.
- B. Perlite: Horticultural perlite, soil amendment grade.
- C. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

2.03 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
 - 1. Feedstock: Limited to leaves.
 - 2. Reaction: pH of 5.5 to 8.
 - 3. Soluble-Salt Concentration: Less than 5-10 dS/m.
 - 4. Moisture Content: 35 to 55 percent by weight.
 - 5. Organic-Matter Content: 50 to 60 percent of dry weight.
 - 6. Particle Size: Minimum of 98 percent passing through a 3/4-inch sieve.

2.04 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 33 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

PART 3 - EXECUTION

3.01 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.02 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate any topsoil from site and stockpile until amended.

- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.03 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 12 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off University's property.
 - 1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
- C. Mixing: Spread unamended soil to total depth indicated on Drawings, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
 - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698 and tested in-place.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.04 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

- B. Subgrade Preparation: Till subgrade to a minimum depth of 12 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off University's property.
- C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
 - 1. Lifts: Apply planting soil in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.05 PROTECTION

- A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.
 - 4. Foot traffic.
 - 5. Erection of sheds or structures.
 - 6. Impoundment of water.
 - 7. Excavation or other digging unless otherwise indicated.
- B. If planting soil or subgrade is over-compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by A/E and replace contaminated planting soil with new planting soil.

3.06 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off University's property unless otherwise indicated.

END OF SECTION

SECTION 32 92 00

TURF AND GRASSES

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. Sodding.
 - 2. No-mow seed mix.
- B. Related Requirements:
 - 1. Section 328400 "Planting Irrigation" for installation of irrigation system.
 - 2. Section 329113 "Soil Preparation" planting soils in lawn areas.
 - 3. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants.

1.03 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by University for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years' experience in turf installation.
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawncare Manager.
 - c. Landscape Industry Certified Lawncare Technician.
 - 5. Pesticide Applicator: State licensed, commercial.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.09 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
 1. Spring Planting: March 15 to May 20.
 2. Fall Planting: August 15 to October 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 TURFGRASS SOD

- A. Turfgrass Species: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
 1. Full Sun: Turf Type Tall Fescue, a minimum of three cultivars.
 2. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 90 percent Turf Type Tall Fescue.
 - b. 10 percent Kentucky bluegrass.

2.02 NO-MOW SEED MIX

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Grass-Seed Mix: Proprietary seed mix as follows:
 1. Products: Subject to compliance with requirements, provide the following (or approved equal):
 - a. Scottish Links by Jacklin Seed - Simplot. (800) 688-7333.

2.03 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.04 MULCHES

- A. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- C. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.05 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.06 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.
- C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by A/E and replace with new planting soil.

3.02 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place planting soil according to Section 329113 "Soil Preparation."
- C. Reduce elevation of planting soil to allow for soil thickness of sod.
- D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- E. Before planting, obtain A/E's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. A clean edge will be made by using a mechanical sod cutter where sod abuts existing turf.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.05 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 4 to 8 lb/1000 sq. ft..
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

3.06 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
 - 2. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.07 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a

uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
 3. Utilize in-ground irrigation system if available.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow grass to a height of 2 to 3 inches.
 2. Do not mow no-mow seed areas.
- D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.08 SATISFACTORY TURF

- A. Upon completion of the work, notify the A/E and University Landscape Architect in writing that the work is ready for final inspection. Request a date for inspection.
1. Notify the University Landscape Architect five (5) days prior to the requested final inspection date.
- B. Turf installations shall meet the following criteria as determined by the A/E and the University Landscape Architect:
1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
 2. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

- C. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.09 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off University's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.11 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
 - 1. Sodded Turf: Maintain until acceptance by University Landscape Architect.
 - 2. Seeded Turf: Maintain until acceptance by University Landscape Architect.

END OF SECTION

SECTION 32 93 00

PLANTS

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. Plants.
 - 2. Tree stabilization.
 - 3. Tree-watering devices.
 - 4. Landscape edging.
 - 5. Landscape boulders.
- B. Related Requirements:
 - 1. Section 328400 "Planting Irrigation" for installation of irrigation system.
 - 2. Section 329113 "Soil Preparation" for reuse of existing topsoil and manufactured topsoil mix.
 - 3. Section 329200 "Turf and Grasses" for coordination with lawns.

1.03 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than sizes indicated; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- D. Finish Grade: Elevation of finished surface of planting soil.
- E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

- F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Area: Areas to be planted.
- H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.
- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- L. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.04 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.05 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:

1. Organic Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

1.07 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 1. Manufacturer's certified analysis of standard products.
 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

1.08 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by University for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.09 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Experience: Five years' experience in landscape installation.
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Interior.
 - c. Landscape Industry Certified Horticultural Technician.
 5. Pesticide Applicator: State licensed, commercial.

- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
 - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: A/E may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. A/E may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 - 1. Notify A/E of sources of planting materials seven days in advance of delivery to site.
 - 2. All trees must be evaluated and approved by the University Landscape Architect prior to planting.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.

- E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - 1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - 2. Do not remove container-grown stock from containers before time of planting.
 - 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 1 to June 1.
 - 2. Fall Planting: September 1 to November 1.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by the University.
 - b. Structural failures including plantings falling or blowing over.

- c. Faulty performance of tree stabilization and edgings.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- 2. Warranty Periods: From date of Substantial Completion.
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
- 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.01 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 - 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
 - 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to A/E, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.02 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 - 1. Size: 10-gram tablets.
 - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.03 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Type: Shredded hardwood.
 - 2. Size Range: 3 inches maximum, 1/2 inch minimum.
 - 3. Color: Natural.
 - 4. Basis of design: Kurtz Bros. brown.

2.04 LANDSCAPE BOULDERS

- A. Limestone boulders, 2' – 5' long, up to 30" thick by Lang Stone (614) 235-4099.

2.05 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.06 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 - 1. Upright and Guy Stakes: Steel, 2-by-2-inch nominal by length indicated, pointed at one end.
 - 2. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles.

3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
4. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
5. Guy Cables: Five-strand, 3/16-inch-diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
6. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

2.07 LANDSCAPE EDGINGS

- A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Border Concepts, Inc.
 2. Edging Size: ¼ inch thick by 5 inches long.
 3. Stakes: Tapered steel, a minimum of 15 inches long.
 4. Accessories: Standard tapered ends, corners, and splicers.
 5. Finish: Weathering steel.

2.08 TREE-WATERING DEVICES

- A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
 1. Color: green.
- B. Watering Pipe: PVC pipe 4 inches in diameter, site-cut to length as required, and with snug-fitting removeable cap. Manufacturers include but are not limited to the following:
 1. RootRain Metro manufactured by GreenBlue, www.greenblue.com
 2. Aeration and Irrigation system manufactured by GreenMax, www.greenmax.eu
 3. Snorkil aeration and irrigation system manufactured by City Green, www.citygreen.com

2.09 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Burlap: Non-synthetic, biodegradable.
- C. Tree trunk protection tube made from corrugated drainage tubing cut to length in the field.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by A/E and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain A/E's and the University's Landscape Coordinator's acceptance of layout before excavating or planting. Make minor adjustments as required.

3.03 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place manufactured planting soil according to Section 329113 "Soil Preparation."
- C. Before planting, obtain A/E's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.
 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 6. Maintain supervision of excavations during working hours.
 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify A/E if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- D. Drainage: Notify A/E if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.
- 3.05 TREE AND SHRUB PLANTING
- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 to 3 inches above adjacent finish grades.
1. Backfill: Planting soil.
 2. Completely remove wire baskets from all root balls.
 3. Completely remove nylon burlap from all root balls.

4. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap and rope from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
5. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
6. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: Three for each caliper inch of plant.
7. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Watering Pipe: During backfilling, install watering pipe 4 feet deep into the planting pit outside the Rootball as indicated on Drawings and with top of pipe 1 inch above the mulched surface.

E. Place tree trunk protection tub around tree trunk.

3.06 TREE AND SHRUB PRUNING

- A. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by A/E, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- B. Do not apply pruning paint to wounds.

3.07 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
 1. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
 2. Upright Staking and Tying: Stake trees with two stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
 3. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
 4. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.08 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. A pre-emergence shall be applied at the time of planting to prevent the seeding in of new weeds.
- G. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- H. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.09 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees: Apply organic mulch ring of 3-inch average thickness, with 24-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.

3.10 LANDSCAPE BOULDERS

- A. Place stone in locations indicated.
- B. Final location of boulders to be approved by Landscape Architect.

3.11 EDGING INSTALLATION

- A. Shovel-Cut Edging: Separate mulched areas from turf areas with a 45-degree, 4- to 6-inch-deep, shovel-cut edge.
- B. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

3.12 INSTALLING SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.13 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.14 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with University's operations and others in proximity to the Work. Notify University before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.15 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by A/E.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by A/E.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition or are damaged during construction operations that A/E determines are incapable of restoring to normal growth pattern.
 - 1. Provide new trees of same size as those being replaced for each tree of 6 inches or smaller in caliper size.
 - 2. Species of Replacement Trees: Same species being replaced.

3.16 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off University's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.17 MAINTENANCE SERVICE

- A. Maintenance Service for Trees: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period: 12 months from date of Substantial Completion.

END OF SECTION

SECTION 33 11 00

WATER DISTRIBUTION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Work Included: Work of this section includes, but is not limited to:
1. Hydrants.
 2. Service lines.
 3. Fittings
 4. Valves
 5. Extension valve boxes.
 6. Valve wrench.
 7. Testing and disinfection.
 8. Obtain and pay for plumbing permits, inspection fees, capacity charges, front footage fees, tapping charges, and street repaving bonds and other governmental fees applicable. Pay all costs involved in providing meter.
 9. Comply with the Columbus Division of Water minimum standards and special requests to conform to their requirements. Requests may include meter arrangement, backflow preventers, special valves or pipe type change.
 10. Excavate street, curb and sidewalks and connect to water main. Repair street, curb and sidewalks.
 11. Excavate and connect to existing water main. Backfill as required.

1.02 RELATED SECTIONS

- A. Excavation and Backfill: Section 31 30 00.
- B. Cast-In-Place Concrete: Section 03 30 00.

1.03 SUBMITTALS

- A. Conform completely to the requirements of the General Conditions and Section 01 33 23.
- B. Reference Standards
- C. Special Guarantees and Warranties
- D. Installer Certification
- E. Material Certification

- F. Test Reports: Provide 2 copies of test reports certified by an independent testing agency.
- G. As-Built Drawings: Indicate deviations from original Construction Documents. Include all buried, concealed utility services, water, fire, etc., dimensioned from a fixed control point, including depth of bury.
- H. Manufacturer's Product Data: Submit for the following:
 - 1. Valves
 - 2. Accessories
 - 3. Pipe
 - 4. Hydrants

1.04 PROJECT CONDITIONS

- A. Location of Existing Lines
 - 1. Make connections to existing lines and new building services as shown and required.
 - a. Location of each existing pipe line shown on the Drawings was determined from available construction records and should be considered approximate.
 - b. Determine the exact location of existing pipes to which connections will be made, or which may be affected by the work in any way.
- B. Taking Existing Lines Out of Service
 - 1. Coordinate all utility service shutdown or outages with the Architect and the Owner. Shut downs shall conform to all utility company requirements. Avoid inconveniencing the Owner and provide temporary service during the curtailment, as required by the Architect or Owner.
 - 2. Existing lines may not be taken out of service unless approved by the Architect.
 - 3. Notify the Architect for approval, at least 48 hours in advance of the desired time for taking any line out of service.
- D. Work on Existing Lines
 - 1. Install temporary plugs in ends of cut lines to keep out mud and debris.
 - 2. Provide all necessary adapters, fittings and pipe required to make connections to existing pipe.
 - 3. Conform to the specifications herein when reinstalling cut pipe or constructing modifications to existing piping.
- E. Connections to Existing Lines: Provide fittings shown or as required to make proper connections.
- F. Abandoned Lines

1. Remove only to the extent necessary to make connections or replace existing lines as indicated.
2. Suitably cap or plug open ends of abandoned lines.

G. Locations and Verifications

1. Coordinate work of this Division with all Civil, Structural, Architectural, Electrical and Plumbing Drawings, including Drawings of associated trades, before installation of this Work or the submission of required Drawings for review or approval.
2. Verify at the Site all locations, elevations, grades and utility service connections, as indicated on the Drawings and serving the Project.

1.05 DELIVERY, STORAGE AND HANDLING

A. Conform to the manufacturer's recommendations and instructions.

B. Handling of Material

1. Use approved equipment and tools for safe and convenient handling and laying of pipe and fittings.
2. Do not drop, roll or skid pipe.

C. Defective Materials

1. Examine piping, fittings and specials to be installed and reject those which are defective or in poor condition.
2. Remove all items which are found to be defective after installation.

PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE AND FITTINGS

A. Comply with the City of Columbus Division of Water approved products list

B. Fittings: Ductile iron.

1. Reference: ANSI A21.10.
2. Class: Same as pipe.
3. Coating: Inside and outside, approved bitumastic or coal tar coating.

C. Flange Adapter: Ductile iron, conforming to ASTM A536, Grade 65-45-12.

1. Drilling: In accordance with ANSI B16.1.
2. Reference: Meet requirements of AWWA 900.

2.03 VALVES AND VALVE BOXES

- A. Gate Valves, Extension Valve Boxes, Valve Wrench, Tapping Sleeve, Tapping Valve, Glands, and Fire Hydrant

- 1. Comply with the City of Columbus Division of Water approved products list

2.06 BLOCKING AND SUPPORTS

- A. Provide cast-in-place concrete blocking and supports for pipe bends, tees, valves, fire hydrants and strapping anchors. Refer to City of Columbus Standard drawings for details. See Section 03 30 00 for concrete.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Verify location and elevation of utility lines and mains to be crossed.
- B. Verify location, elevation, pipe class and dimensions of lines to which connections are to be made prior to proceeding with connection.

3.03 EXCAVATION AND BACKFILL

- A. General: Conform to CCMS 603.03 and the following:
 - 1. Trench Excavation: Follow lines and grades as indicated on plans.
 - a. Exact positions shall be subject to and adjusted to interferences with other work.
 - 2. Width of Trench: Approximately 2 feet wider than pipe diameter.
 - a. Additional trench width will be permitted, as approved by the Architect, when using sheeting, bracing or timbering in the pipe zone.
 - 3. Leave trenches open until work is inspected.
 - 4. Uncover existing pipes and cables ahead of trenching for new work.
- B. Water and Fire Lines
 - 1. Water and fire lines shall follow alignment as shown on plans with a minimum depth of cover of 5' below finish grade.
 - 2. Excavate trench bottoms to a point that undercuts the entire pipe a minimum of 6 inches, including the joints. Backfill undercut with granular material to a point so that a template or hand shovel can be used to shape the material to fit the lower quadrant of the pipe in its entire length between joints. AWWA C600 Sections 6.5 and 6.10 do not apply.

3.04 INSTALLATION

A. General

1. Conform to AWWA C600 "Standard for Installation of Ductile-iron Water Mains and their Appurtenances. Maintain a copy of this standard at the job site.
2. Lay pipe and fittings true to line and grade and in accordance with manufacturer's recommendations.
3. Use approved equipment and tools for safe and convenient handling and laying of pipe and fittings.
4. Examine all pipe and fittings before installation for apparent defects. Mark individual defective materials with paint and promptly remove from site.
5. Remove and replace defective pipe or fittings that are incorporated in the work.
6. Thoroughly clean pipe and fittings prior to laying and maintain in clean condition until accepted by Owner.
7. Schedule work so that a maximum of 200 feet of trench is open at any one time unless otherwise approved by Architect. A trench is considered closed when it is completely backfilled and the temporary or permanent pavement has been placed.
8. Field touch-up protective coatings prior to backfilling.

B. Manufacturer's Representative

1. Secure the services of a competent manufacturer's installation specialist when pipe laying begins.
2. Retain foregoing specialist on job until the competency of the laying crew has been demonstrated to the satisfaction of the Architect.
3. The above requirements may be waived if in the opinion of the Architect such services are unnecessary.
4. Include cost of instructor's services with cost of pipe.

C. Pipe and Fittings

1. Do not damage coating, particularly on inside of pipe/fittings.
2. Use combination of fittings and/or small joint deflections wherever changes in line or grade do not correspond to standard fitting alignment.
3. Do not exceed maximum joint deflection recommended by AWWA C600.
4. Use mechanical joint anchoring fittings where indicated.

D. Pipe Supports

1. Provide concrete backing for all tees and bends 11-1/4" and larger.
2. Provide concrete anchoring blocks as indicated.
3. See Section 03 30 00 for concrete.

E. Valves

1. Install at locations indicated on drawings.
2. Install in strict accordance with manufacturer's recommendations.
3. Provide concrete valve supports. Do not encase or permit concrete to spill on bolts, operator or joints.
4. Thoroughly tamp backfill around base of valve to insure proper vertical alignment.

F. Valve Boxes

1. Adjust tops of all valve boxes shall be adjusted to top of pavement or to 1" above finish grade unpaved areas.
 - a. Concrete collars shall be provided in unpaved areas.
2. Do not allow base to contact valve body. Provide 2 inch clearance.
3. Maintain plumb during backfilling operations.

G. Tapping Sleeves and Valves

1. Install where indicated on the drawings.
2. Install under pressure in strict accordance with manufacturer's recommendations.
3. Test under 150 psi pressure prior to cutting operations. If leaks appear, make repairs and retest.

H. Connections to Existing Mains: Provide fittings shown or as required to make proper connections.

I. Abandoned Lines

1. Remove to extent necessary to make connections or replace existing line.
2. Cap or plug open ends of abandoned lines.

J. Additional Fittings

1. Base water main bids on fittings indicated or as required to install the water main as indicated.
2. Install additional fittings as ordered in writing by the Architect.
3. If fittings different than those indicated on the drawings are required, the differences in weights will be paid for at the Unit Price Bid.

3.05 TESTING

A. General: The following tests are minimum requirements, in addition, all requirements of the City of Columbus Division of Water must be satisfied:

1. Provide all materials and equipment necessary to perform tests.
2. Owner will furnish water.

B. Testing Service Lines

1. Test under normal operating water pressure.
2. Repair leaks before backfilling.
3. Following testing of mains and service lines and before backfilling service lines, open all corporation stops and close all curb stops.
4. Blow out service lines after completion.

3.06 DISINFECTION

A. Conform to requirements of AWWA 651, except as modified herein.

1. Before being placed in service, flush and disinfect all new mains and repaired portions or extensions of existing mains.
2. Use special precautions specified in AWWA C651 Section 11 when cutting into existing lines.
3. Flush lines as thoroughly as possible prior to chlorination and after testing has been completed.
4. Disinfect, using chlorine solution made from liquid chlorine or from HTH or similar chlorine bearing compounds in water. Apply a dose of 50 to 100 mg/l to the water when using the continuous feed system.
5. Flush treated water from the pipe line until the replacement water proves to be comparable in quality to that provided by the water supply system. Satisfactory quality water delivered by the new main should continue for at least two days as demonstrated by laboratory analysis of samples.

B. Repeat procedures until satisfactory results are obtained.

C. Testing Laboratory: Hired and paid for by the Contractor. Laboratory selected must be approved by Architect prior to hiring.

END OF SECTION

SECTION 33 41 00
STORM SEWER SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Storm sewer work, including:
 - 1. Storm drainage pipe.
 - 2. Downspout extension pipe.
 - 3. Underground Detention System

- B. Obtain and pay costs for all necessary permits, fees, inspections, etc., for work of this Section.

1.02 RELATED SECTIONS

- A. Sanitary Sewers: Section 33 31 00.

- B. Downspout Boot: Section 05 50 00.

1.03 SUBMITTALS

- A. Submit product data for manufactured items in accordance with the requirements of the General Conditions and Section 01 33 23.

1.04 QUALITY ASSURANCE

- A. Locations and Verifications
 - 1. Coordinate the work of this Division with all Site Work, Structural, Architectural, Electrical and Plumbing Drawings, including Drawings of associated trades, before installation of this Work or the submission of required Drawings for review or approval.
 - 2. Verify at the Site all locations, elevations, grades and utility service connections, as indicated on the Drawings and serving the Project.

1.05 PROJECT CONDITIONS

- A. Location of Existing Lines

1. Contractor shall make connections to existing lines and new building services as shown and required.
 - a. The location of each existing pipe line shown on the Drawings was determined from available construction records and should be considered approximate.
 - b. Before installation, Contractor is responsible for determining the exact location of any existing pipe to which he must make connections, or which he may disturb during earth moving operations, or which may be affected by his work in any way.
- B. Taking Existing Lines out of Service
 1. Existing lines may not be taken out of service unless approved by the Architect.
 2. Notify the Architect for approval, at least 48 hours in advance of the desired time for taking any line out of service.
- C. Work on Existing Lines
 1. Install temporary plugs in ends of cut lines to keep out mud and debris.
 2. Provide all necessary adaptors, fittings and pipe required to make connections to existing pipe.
 3. Conform to the specifications herein when reinstalling cut pipe or constructing modifications to existing piping.
- D. Concrete Work: Unless otherwise noted, all concrete material and installation shall be as required in Section 03 30 00.
- E. Utility/Service Connections
 1. Maintain close coordination to ensure proper elevations and locations at point of final connection between Site and building utilities.
 2. Make provisions to allow for settlement and shifting by the use of supports, swing connections or other installation approved by the utility company, at the building line to ensure stability of the lines and protection against failure.

PART 2 PRODUCTS

2.01 SEWER PIPE

- A. Sewer Lines: HDPE, Concrete, or PVC.
- B. Sewer Pipe and fittings shall conform to the requirements of CCMS Item 901 and referenced sections.

2.02 ARCHED CHAMBER DETENTION SYSTEM

- A. Stormtech SC-740 Chamber system by ADS

2.03 CATCH BASINS and MANHOLES

- A. Provide precast catch basin to meet the standard details and specification as outlined in the City of Columbus Standard Construction Drawings and Construction and Material Specifications.

PART 3 EXECUTION

3.01 EXCAVATION AND BACKFILL

- A. General: Conform to Section 31 30 00 and the following:
 - 1. Trench Excavation: Follow lines and grades as indicated on plans.
 - a. Exact positions shall be subject to and adjusted to interferences with other work.
 - 2. Width of Trench: Approximately 2 foot wider than pipe diameter.
 - a. Additional trench width will be permitted, as approved by the Architect, when using sheeting, bracing or timbering in the pipe zone.
 - 3. Leave trenches open until work is inspected.
 - 4. Uncover existing pipes and cables ahead of trenching for new work.

3.02 INSPECTION

- A. Contractor must examine the areas and conditions under which storm sewer work is to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.03 INSTALLATION - MISCELLANEOUS

- A. Install miscellaneous site drainage items as indicated on drawings.
- B. CCMS or ODOT referenced items shall conform to the various CCMS or ODOT specification sections referenced in Part 2 herein.

3.04 INSTALLATION - STORM SEWER

- A. General
 - 1. Install full lengths of pipe, where practical.
 - 2. Request instructions from the Architect when there is a conflict between the manufacturer's recommendations and the Drawings or Specifications.
 - 3. Make joints in accordance with manufacturer's recommendations.
 - 4. Trench and backfill as indicated in Section 31 30 00.
 - 5. Lay pipe in dry trench. Line may be partially backfilled, leaving joints open until after testing.
 - 6. Leave line clean and free of debris when complete.
- B. Storm Sewer

1. Laying Pipe
 - a. Install all piping true to line and grade.
 - b. Slope all piping uniformly between elevations given.
 - c. Do not lay pipe in water.
 - d. Start at lowest point and proceed opposite to direction of flow when installing sewers and drains.
 - e. Place bell and spigot pipe so that bells face the direction of laying unless otherwise approved by the Architect.
 - f. Excavate bedding to provide bell holes so that after placement only the barrel of the pipe receives bearing pressure from the trench bottom.
 - g. Start bell and spigot drain and sewer pipe so that the bells face upstream or in the direction opposite to the flow, unless otherwise shown on the Drawings.
 - h. Do not deflect pipe joints more than three-fourths of manufacturer's recommended maximum deflection.
 - i. Thoroughly clean pipe and fittings before laying and making connection.
2. Protection of Pipe During Laying Operations
 - a. Prevent water from flowing through or around pipe during laying operations.
 - b. Place temporary caps or plugs over all pipe openings temporarily halted on a particular line, to protect mud and debris from entering the piping.
3. Transitions from One Type of Pipe to Another
 - a. Encase all joints with concrete where a transition is made from one type of pipe to another unless otherwise specified herein or shown on the Drawings. Make concrete at least 6 inches thick all around and not less than 1 foot each side of the connecting joint.
 - b. Provide all necessary adapters or specials when connecting pipe made by different manufacturers.
4. Connections to Existing Structures
 - a. Install as specified herein, unless otherwise shown on the Drawings.
 - b. Cut an opening in existing catch basin so that opening is no larger than necessary to insert pipe.
 - c. Provide all necessary pipe, fittings, concrete and other materials required to make connection.
 - d. Cast a concrete collar around newly connected pipe on exterior of catch basin to seal joint. Make collar at least 6 inches thick in each direction.
 - e. Modify the invert channel in manhole, if necessary, to provide smooth flow into and out of pipe.

C. Cleaning

1. Clear the interior of all pipe of dirt and other superfluous material. Maintain a swab or drag in the line and pull past each joint as it is completed.
2. Place plugs in the ends of uncompleted pipe at the end of the day or

whenever work stops.

3. Flush lines if required to remove collected debris.

D. Inspection

1. Inspect pipe to determine whether line displacement or other damage has occurred.
2. Make inspection after lines between catch basins have been installed and approximately two feet of backfill is in place and at completion of the project.
3. If the inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, take whatever steps are necessary to correct these defects.

3.05 TESTING

- A. Perform testing of complete sewer system in accordance with requirements of the City of Columbus Division of Sewerage and Drainage.
- B. Perform all tests before piping joints are covered or concealed. Tests shall be witnessed by the Architect.
- C. Submit a written report of tests to the Architect.

END OF SECTION

SECTION 33 49 00

STORM DRAINAGE STRUCTURES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Work of this Section includes, but is not limited to all types of manholes, catch basins, and curb inlets.

1.02 RELATED SECTIONS

- A. Excavation and Backfilling: Section 31 30 00.
- B. Concrete: Section 03 30 00.
- C. Masonry: Section 04 00 00.
- D. Storm Sewers: Section 33 41 00.

1.03 SUBMITTALS

- A. Submit product data for the following items in accordance with the requirements of the General Conditions and Section 01 33 23.
 - 1. Standard and special precast concrete manhole components.
 - 2. Precast concrete manhole assemblies.
 - 3. All types of metal castings.
 - 4. Manhole steps.

1.04 PROJECT CONDITIONS

- A. Location of Existing Lines
 - 1. Contractor shall make connections to existing lines and new building services as shown and required.
 - a. The location of each existing pipe line shown on the Drawings was determined from available construction records and should be considered approximate.
 - b. The Contractor is responsible for determining the exact location of any existing pipe to which he must make connections, or which he may disturb during earth moving operations, or which may be affected by his work in any way.
- B. Taking Existing Lines Out of Service

1. Existing lines may not be taken out of service unless approved by the Architect.
2. Notify the Architect for approval, at least 48 hours in advance of the desired time for taking any line out of service.

C. Work on Existing Lines

1. Install temporary plugs in ends of cut lines to keep out mud and debris.
2. Provide all necessary adaptors, fittings and pipe required to make connections to existing pipe.
3. Conform to the specifications herein when reinstalling cut pipe or constructing modifications to existing piping.

PART 2 PRODUCTS

2.01 PRECAST REINFORCED CONCRETE MANHOLE COMPONENTS

A. Standard: ASTM C478.

B. Definition: Precast reinforced concrete manhole components as used herein includes base sections, transition sections, riser sections, cone sections, flat slab tops and grade rings.

C. Design and Construction

1. General: Meet the requirements of the referenced standard and supplemental requirements listed below. All drainage structures are to meet the requirements of CCMS Item 604 and be stamped by the City of Columbus.
2. Joints Between Precast Components
 - a. Rubber gasket type conforming to ASTM C443.
 - b. Bell up or bell down construction acceptable.
 - c. Rubber gaskets not required at grade ring joint.
3. Pipe Connections: As specified herein below.
4. Dimensions: As indicated on the Drawings.

D. Pipe Connections

1. Type
 - a. Resilient Connectors: Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923. Kor-N-Seal manufactured by NPC, INC., PSX manufactured by PRESS SEAL GASKET CORP., or equal.
 - b. Other: Provide cast opening suitable for mortared joint. Openings MUST be placed in manhole sections at time of manufacture.
2. Maximum Size of Pipe Connected to Precast Components
 - a. 48 In. I.D. Bases or Risers: 24 in.
 - b. 60 In. I.D. Bases or Risers: 36 in.
3. Minimum Distance from Edge of Opening for Pipe Connection to End of

- Full Wall Thickness at Joints: 6 inches.
- 4. Minimum Separation Between Barrels of Adjacent Pipes: 6 inches.
- 5. Criteria for Determining Number and Size of Pipe Openings which may be Cast in a Base or Riser Section:
 - a. Sum of outside diameters of pipes must not exceed 50% of the inside circumference in any given horizontal plane of a precast component.
 - b. Recommendations of precast concrete manufacturer is less than the foregoing 50% criteria.
- 6. Pipe Connections in Cone Sections: Not acceptable.

2.04 MANHOLE STEPS

- A. Manufacturer and Model: NEENAH FOUNDRY CO., Fig. No. R-1982-J, CAMPBELL FOUNDRY or EAST JORDAN IRON WORKS, INC.
- B. Material: Cast iron, ASTM A48, Class 30; steel reinforced plastic may be used.
 - 1. Plastic: PS1-PF manufactured by MA Industries, ML-10 manufactured by American Step Company, Inc. or equal
- C. Minimum Design Live Load: 300 lbs. concentrated and located so as to cause the maximum stress in manhole wall.
- D. Dimensions
 - 1. Maximum Spacing: 12 inches.
 - 2. Minimum Width: 16 inches.
 - 3. Minimum Embedment: 5 inches.
 - 4. Project From Face of Wall: 7 inches.
- E. Finish: Free of sharp edges and burrs and painted with an approved asphalt paint.

2.05 CASTINGS

- A. Type: As indicated on drawings.
- B. Manufacturer: NEENAH FOUNDRY COMPANY; CAMPBELL FOUNDRY or EAST JORDAN IRON WORKS, INC.
- C. Material: Cast iron, ASTM A48, minimum Class 30, unless otherwise indicated on drawings.
- D. Finish: Coat with an approved asphalt paint.
- E. Labels Cast in Manhole Lids

1. Sanitary Sewer Manhole: "SANITARY SEWER".
2. Storm Drain Manhole: "STORM SEWER".

PART 3 EXECUTION

3.01 GENERAL

- A. Manhole Construction: Unless specifically called out on the Drawings, the Contractor may use one of the following three methods:
 1. Complete cast-in-place construction.
 2. Precast manhole sections on a cast-in-place base.
 3. Precast base and manhole sections assembled in the field.
- B. All Other Miscellaneous Structures: Cast-in-place construction, masonry construction or precast construction at Contractor's option.
- C. Changes in Type of Construction: If the Contractor wishes to deviate from the foregoing rules concerning type of construction, he must submit complete design details to the Architect for approval.

3.02 INSTALLATION OF PRECAST MANHOLE COMPONENTS

- A. General
 1. Install in accordance with manufacturer's recommendations and details as shown on the Drawings.
 2. Obtain Architect's approval before making any field modifications.
- B. Bases
 1. Over-excavate a minimum of 6 inches to suitable undisturbed soil.
 2. Compact granular material in bottom of excavation and grade to level surface.
 3. Place concrete collar around joint between flat slab base sections and first riser section.
- C. Miscellaneous
 1. Lift Holes: Fill with mortar.
 2. Steps: Install as shown on the Drawings and align vertically.
 3. Grade Rings: Brick or precast. If brick is used, coat with 1/2 inch of mortar inside and outside.
 4. Pipe Joints
 - a. Resilient Joints: Comply with manufacturer's recommendations concerning installation.
 - b. Joints for Pipes 12 Inches and Larger: Cast concrete collar around joint as shown on the Drawings and insure the joint is completely sealed.

3.03 DROP MANHOLES

- A. General: Drop manholes are required when the top of the incoming pipe is more than 3 ft. from the invert of the base.
- B. Construction: As indicated on the drawings.

3.04 CHANNEL INVERTS IN MANHOLES

- A. Use half section of pipe or shape concrete fill at Contractor's option unless otherwise shown on the Drawings.

3.05 STUBS IN MANHOLES

- A. General: Provide as indicated on the drawings.
- B. Stub Length: One standard pipe length, unless otherwise indicated on the drawings.
- C. Plugs and Bulkheads
 - 1. Install in both ends of stub, i.e., in manhole and at opposite end.
 - 2. Use brick or precast concrete on concrete pipe and iron plugs or caps on iron pipe.
 - 3. Construct brick bulkheads with the following minimum thickness:
 - a. 24 in. and smaller pipe: 4 in.
 - b. 27 through 42 in. pipe: 8 in.
 - c. Over 42 in. pipe: 12 in.
 - 4. Coat exposed brick surfaces at each end of stub with 1/2 in. of mortar.

3.06 NEW MANHOLE ON EXISTING SEWER

- A. Exact Location: Determined in field by Contractor. See paragraph 1.03, A.1., herein.
- B. Channel Construction: Provide as necessary to direct flow as required.
- C. Existing Sewer: Protect, support and replace as required to prevent damage.
- D. Abandoned Sewer: Plug using methods reviewed by Architect.

3.07 MANHOLE FRAME (RING) AND COVER REINSTALLATION

- A. Where indicated, remove the existing manhole frame and cover. It shall be the responsibility of the Contractor, at no additional cost to the Owner, to repair any portion of the brick and mortar ring of the manhole which is damaged when the existing frame and cover are removed.

- B. Adjust the elevation of the manhole as indicated on the drawings or as directed by Architect to align with new paving elevations. Raise manholes by adding a sufficient number of brick and mortar rings or precast concrete grade rings to obtain the desired elevation.
- C. Reinstall manhole frame and cover.

END OF SECTION