

PROJECT MANUAL

CMHA HARRIET'S HOPE

**1581 WEST BROAD STREET
COLUMBUS, OHIO 43222**

PREPARED FOR:



**COLUMBUS METROPOLITAN
HOUSING AUTHORITY**
COMMUNITY. COMMITMENT. COLLABORATION.

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COLUMBUS, OHIO

PREPARED BY:



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VOLUME 2

**PERMIT & BID DOCUMENTS
APRIL 4, 2022**

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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 22 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. Gate valves.
 - 5. Globe valves.
 - 6. 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. 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 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.

2.7 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.

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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. 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 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. 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, 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 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.

- 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 inturred 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.

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 inturred 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 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, 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. 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 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-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - 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

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. Contractor to perform a flow test and utilize results of flow test for system design. Utilize values listed above for preliminary 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 University 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 University 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 University'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.
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. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping."
- 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 DEMONSTRATION

- A. Engage a factory-authorized service representative to train University's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.13 PIPING SCHEDULE

- A. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be the following:
 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
- B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be the following:
 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. 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.

3.14 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
 3. Wall Mounting: Sidewall sprinklers.
 4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
 5. 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. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 4. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

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, 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. Terice, 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. Terice, 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, Trerice, 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: Trerice, 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.
- 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.
- 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. 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.

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.

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.

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.

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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. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Pipe stands.
 - 6. 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. Pipe stands.
 - c. 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.

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. 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 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.

2.4 FASTENER SYSTEMS

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

2.5 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.

2.6 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. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely

- cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. 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.
- 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 copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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.
- J. 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.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - 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.
- M. 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.
- N. 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.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 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 cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; 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. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Safety green.
 - b. Letter Color: White.
 - 3. Fuel Gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

4. 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. 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%.
- F. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL.

- Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
2. 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.
 3. 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.
 - G. 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. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. 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.
- E. 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. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

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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 the University or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 1. Notify the University's representative no fewer than two days in advance of proposed interruption of water service.
 2. Do not interrupt water service without the University'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.

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. Push-on-Joint, Ductile-Iron Pipe:
1. AWWA C151/A21.51.
 2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- E. Standard-Pattern, Push-on-Joint Fittings:
1. AWWA C110/A21.10, ductile or gray iron.
 2. Gaskets: AWWA C111/A21.11, rubber.
- F. Compact-Pattern, Push-on-Joint Fittings:
1. AWWA C153/A21.53, ductile iron.
 2. Gaskets: AWWA C111/A21.11, rubber.
- G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.
- H. 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 CPVC PIPING

- A. CPVC Pipe: ASTM F 441/F 441M, Schedule 80.
 - 1. CPVC Socket Fittings: ASTM F 439 for Schedule 80.
 - 2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
- B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
- C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.5 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.

2.6 PEX-AL-PEX TUBE AND FITTINGS

- A. PEX-AL-PEX Distribution System: ASTM F 1281 tubing.
- B. Fittings for PEX-AL-PEX Tube: ASTM F 1281, metal-insert type with copper or stainless-steel crimp rings and matching PEX-AL-PEX tube dimensions.

2.7 PEX-AL-HDPE TUBE AND FITTINGS

- A. PEX-AL-HPDE Distribution System: ASTM F 1986 tubing.
- B. Fittings for PEX-AL-HDPE Tube: ASTM F 1986, metal-insert type with copper or stainless-steel crimp ring and matching PEX-AL-HDPE tube dimensions

2.8 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. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
 - 1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. 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).
 - 3. Solvent cement and 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."
- G. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.9 ENCASEMENT FOR PIPING

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

2.10 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.

2.11 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 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 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 thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- U. 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."
- 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 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. 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. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- K. Joint Construction for Solvent-Cemented Plastic Piping: 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.
- L. Joints for PEX Piping: Join according to ASTM F 1807.

- M. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 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.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 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 hangers for stainless-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.
- J. Install supports for vertical stainless-steel piping every 15 feet.
- K. Install vinyl-coated hangers for CPVC 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 CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- M. 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.
- N. Install hangers for vertical PEX piping every 48 inches.
- O. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 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.

3.8 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.

3.9 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.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

- 1. Close drain valves, hydrants, and hose bibbs.
- 2. Open shutoff valves to fully open position.
- 3. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm 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.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. 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. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
 - 3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- E. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
 - 1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
 - 2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
 - 2. PP, SDR 11 socket fittings; and fusion-welded joints.
- G. Aboveground domestic water piping, NPS 2 and smaller shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L, ASTM B 88, Type M; cast or wrought-copper, solder-joint fittings; and soldered joints.
2. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
3. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. NPS 1-1/2 and NPS 2 CPVC pipe with CPVC socket fittings may be used instead of tubing.
4. PEX tube, NPS 1 and smaller; fittings for PEX tube; and crimped joints.
5. PEX-AL-PEX tube, NPS 1 and smaller; fittings for PEX-AL-PEX tube; and crimped joints.

H. 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; wrought-copper, solder-joint fittings; and soldered joints.

I. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball 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

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Strainers.
6. Hose bibbs.
7. Wall hydrants.
8. Drain valves.
9. Water-hammer arresters.
10. 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 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.

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. 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.

D. 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.

E. 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 valve with two readout ports and memory-setting indicator.
4. Body: 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. 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.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

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. Cash Acme; a division of Reliance Worldwide Corporation.
 - c. Conbraco Industries, Inc.
 - d. Honeywell International Inc.
 - e. Legend Valve.
 - 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 1017.
4. Pressure Rating: 125 psig.
5. Type: Thermostatically controlled, water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded inlets and outlet.
8. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Valve Finish: Rough bronze.

B. 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. Bradley.

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. Valve Finish: Rough bronze.

2.7 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.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Factory-installed, hose-end drain valve.

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. 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 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.

2.11 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: Copper tube with piston.
5. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 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 balancing valves in locations where they can easily be adjusted.
- C. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
- D. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.
- E. Install water-hammer arresters in water piping according to PDI-WH 201.
- F. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

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 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Pressure vacuum breakers.
 2. Reduced-pressure-principle backflow preventers.
 3. Primary, thermostatic, water mixing valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test each pressure vacuum breaker and reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

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

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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.
- 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/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.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by the University or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify University no fewer than two days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without University'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.

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

- A. Pipe and Fittings: ASTM A 74, Service 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 ABS PIPE AND FITTINGS

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
- C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
- D. Solvent Cement: ASTM D 2235.

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.

- D. Solvent Cement: ASTM D 2564.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 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. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow.
 - 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- 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."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- Q. Install aboveground ABS piping according to ASTM D 2661.
- R. Install aboveground PVC piping according to ASTM D 2665.
- S. Install underground ABS and PVC piping according to ASTM D 2321.
- T. 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.
- U. 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.
- V. Install force mains at elevations indicated.
- W. 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."
- X. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Y. 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."
- Z. 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."
- AA. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 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. 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.
- F. 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.

3.4 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.
- 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.
- 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. 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. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. 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 hubless-piping couplings; and coupled joints.
 - 3. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. 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 hubless-piping couplings; and coupled joints.
 - 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Underground, soil, waste, and vent piping NPS 8 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 - 2. Solid wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

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SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Roof flashing assemblies.
 - 4. Through-penetration firestop assemblies.
 - 5. Flashing materials.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. 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. Grease interceptors.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 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.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. ASME A112.36.2M, Cast-Iron Cleanouts:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following manufacturers:
 - 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. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hubless, cast-iron soil pipe test tee or Stainless-steel tee with side cleanout as required to match connected piping.

5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

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

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

- 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.

2. ASME A112.36.2M, Stainless-Steel Cleanouts:

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

- 1) Josam Company.
- 2) Kusel Equipment Co.
- 3) Smith, Jay R. Mfg. Co.

3. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
4. Size: Same as connected branch.
5. Type: Threaded, adjustable housing.
6. Body or Ferrule: Cast iron or stainless steel.
7. Clamping Device: Required.
8. Outlet Connection: Threaded.
9. Closure: Brass plug with straight threads and gasket.
10. Adjustable Housing Material: Cast iron.
11. Frame and Cover Material and Finish: Nickel-bronze, copper alloy or stainless steel.
12. Frame and Cover Shape: Round.
13. Top Loading Classification: Medium Duty.
14. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
15. Standard: ASME A112.3.1.
16. Size: Same as connected branch.
17. Housing: Stainless steel.
18. Closure: Stainless steel with seal.
19. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following manufacturers:
 - 1) Josam Company; Josam Div.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe; Wade Div.
 - 5) Watts Drainage Products.
 - 6) Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk brass or cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

D. Plastic Floor Cleanouts:

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

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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

- 3) MIFAB, Inc.
- 4) Prier Products, Inc.
- 5) Smith, Jay R. Mfg. Co.
- 6) Tyler Pipe; Wade Div.
- 7) Watts Drainage Products.
- 8) Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.6.3.
3. Refer to drawings for characteristics.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following manufacturers:
 - 1) Acorn Engineering Company; Elmdor/Stoneman Div.
 - 2) Thaler Metal Industries Ltd.
2. 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.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following manufacturers:
 - 1) ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.5 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. 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.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. 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.
- G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- H. 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.
- I. 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.
- J. 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.
- K. 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.
- L. Install fixture air-admittance valves on fixture drain piping.
- M. Install stack air-admittance valves at top of stack vent and vent stack piping.
- N. Install air-admittance-valve wall boxes recessed in wall.
- O. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

- P. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- Q. Install through-penetration firestop assemblies in plastic conductors at floor penetrations.
- R. Assemble open drain fittings and install with top of hub 2 inches above floor.
- S. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- T. 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.
- U. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- V. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- W. Install vent caps on each vent pipe passing through roof.
- X. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- Y. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- Z. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- AA. 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.
- BB. Install wood-blocking reinforcement for wall-mounting-type specialties.
- CC. 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. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

- D. 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. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled grease removal devices and their installation, including piping and electrical connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. 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.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train University 's maintenance personnel to adjust, operate, and maintain grease removal devices. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 22 13 19

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. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 3. Flow-control, electric, tankless, domestic-water heaters.
 - 4. Thermostat-control, electric, tankless, domestic-water heaters.
 - 5. 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. 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."
- F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.
- G. 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.
- H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- K. 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.
- L. 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. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- C. 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."

- D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. 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.
- F. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. 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."
- H. 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."
- I. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- J. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- K. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig . Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."
- L. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- M. Fill electric, domestic-water heaters with water.
- N. Charge domestic-water compression tanks with air.

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.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain electric, domestic-water heaters.

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. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 1. For lavatories and faucets to include in operation and maintenance manuals.
 2. For sinks to include in maintenance manuals.
 3. For shower faucets to include in maintenance manuals.
 4. For wash fountains and components to include in operation and maintenance manuals.
 5. For drinking fountains to include in maintenance manuals.
 6. For remote water coolers to include in maintenance manuals.
 7. 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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 3. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no less than 1 of each.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

A. Acceptable Manufacturers

1. Plumbing Faucets: Chicago Faucet, American Standard, Kohler, Symmons, Speakman, and Moen.
2. Flush Valves: Sloan, Moen and Zurn.
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. Closet Seats: Church, Sperzel, Bemis, Beneke, and Centoco.
7. Shower Mixing Valves: Powers, Leonard, Lawler, and Bradley.
8. Stainless Steel Sinks: Elkay, Just, Metcraft, and Southern Kitchens.
9. Electric Water Coolers: Elkay, Haws, Oasis, and Halsey-Taylor.
10. Precast Shower Receptacles: Fiat, Stern and Williams, Creative Industries.
11. Prefabricated Showers and Tubs: Fiat, Kohler, Aquaglass, Aquatic.
12. Laundry Tubs: Fiat, Stern/Williams, Mustee.
13. Lavatory Systems: Bradley, Acorn, Intersan.
14. 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. Style: Tank type.
 - d. Height: Standard and ADA.
 - e. Rim Contour: Elongated.
 - f. Water Consumption: **1.6 GPF**.
 - g. Outlet Location: **bottom**.
 - h. Color: To be selected by Architect.
2. Bowl-to-Drain Connecting Fitting: ASME A112.4.3.

2.3 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 or three holes.
 - d. Faucet-Hole Location: Top.
 - e. Color: To be selected by Architect.
 - f. Mounting Material: Sealant, undercounter mounting kit.
 - g. Faucet: Manual.
- 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: Manually Operated
 - a. Manual-type, single-control mixing or two-handle mixing 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: Centerset or 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) Valve Handle(s): Single lever or Lever.
 - 9) Spout: Rigid type.
 - 10) Spout Outlet: Laminar flow.
- C. Laminar-Flow, Faucet-Spout Outlets
 - 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. Description: Chrome-plated brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.
- D. 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.

E. 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.

2.4 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. Finish: Chrome plated or polished chrome plate.
8. Maximum Flow Rate: 2.2 GPM.
9. Handle(s): Lever.
10. Mounting Type: Wall, exposed.
11. Spout Type: Rigid, solid brass with wall brace.
12. Vacuum Breaker: Required for hose outlet.
13. Spout Outlet: Hose thread according to ASME B1.20.7.

2.5 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 or two.
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 or two-handle 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 or Single hole.
 - 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): Single lever or Lever.
 - i. Spout: Swing, round tubular type.
 - j. Spout Outlet: Laminar flow.

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.

2.6 SHOWERS

A. Individual Showers

1. Manufacturers: Subject to compliance with requirements:
 - a. General: ADA and non-ADA shower enclosure with faucet and receptor and appurtenances.
 - b. Standard: ANSI Z124.1.2.
 - c. Type: One-piece unit or Sectional unit.
 - d. Style: Standard residential or Handicapped/wheelchair.
 - e. Nominal Size and Shape: 60 by 34 to 36 inches rectangular.

- f. Bathing Surface: Slip resistant according to ASTM F 462.
 - g. Shower Rod and Curtain: Required.
 - h. Grab Bar: ASTM F 446, mounted on support area back wall (where required).
- 2. Shower Mixing Valves
 - a. 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.
 - b. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
 - c. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - d. Body Material: Solid brass.
 - e. Finish: Polished chrome plate.
 - f. Mounting: Concealed.
 - g. Operation: Single-handle, twist or rotate control.
 - h. Antiscald Device: Integral with mixing valve.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
- 3. Shower Head
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Ball joint with arm and flange.
 - c. Shower Head Material: Metallic with chrome-plated finish.
 - d. Shower-Arm, Flow-Control Fitting: 1.5 GPM.

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: Bi-level with two attached cabinets.
 - 4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 - 5. Control: Push bar.
 - 6. Filter: One or more water filters complying for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
 - 7. 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.
 - 8. 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
 - 9. 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. Install toilet seats on water closets.

B. 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."

C. 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."

D. Showers

1. Assemble shower components according to manufacturers' written instructions.
2. Install showers level and plumb according to roughing-in drawings.
3. Install water-supply piping with stop on each supply to each shower faucet.
 - a. Exception: Use ball, gate, or globe valves if supply stops are not specified with shower. 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.
4. Install shower flow-control fittings with specified maximum flow rates in shower arms.
5. Set shower receptors or shower basins in leveling bed of cement grout.
6. 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 escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

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

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 University.

END OF SECTION 22 40 00

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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. HVAC Pipe and Pipe Fittings
 - 2. Joining Materials
 - 3. HVAC Sleeves
 - 4. HVAC Sleeve Seals
 - 5. HVAC Specialties
 - 6. HVAC Piping System Installation
 - 7. HVAC Equipment Installation
 - 8. Erection of Metal Supports
 - 9. Erection of Wood Supports
 - 10. Cutting and Patching

1.2 REFERENCES

- A. ASTM International (ASTM) Publications: (Former American Society for Testing and Materials)
 - 1. A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless"
 - 2. B32 "Standard Specification for Solder Metal"
 - 3. C1107 "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)"
- B. American Welding Society (AWS) Publications:
 - 1. BRH "Brazing Handbook"
 - 2. A5.8 "Specification for Filler Metals For Brazing And Braze Welding"
 - 3. D1.1 "Structural Welding Code - Steel"
 - 4. D10.12 "Guide for Welding Mild Steel Pipe"
- C. Copper Development Association (CDA) Publications:
 - 1. "Copper Tube Handbook"

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, crawl spaces, and tunnels.

- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
 - 1. Product Data: For dielectric fittings, flexible connectors, plumbing sleeve seals, and identification materials and devices.
 - 2. Coordination Drawings: Detail major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - a. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - b. Clearances for installing and maintaining insulation.
 - c. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - d. Equipment and accessory service connections and support details.
 - e. Exterior wall and foundation penetrations.
 - f. Fire-rated wall and floor penetrations.
 - g. Sizes and location of required concrete pads and bases.
 - h. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - i. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

1.5 QUALITY ASSURANCE

- A. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting plumbing and electrical services,

circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases.

1. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design requirements. See drawings for equipment schedules and requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate HVAC equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of HVAC systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces.
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.8 POSTED OPERATING INSTRUCTIONS

- A. Provide and post operating instructions for all HVAC systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Avendra, LLC Preferred Manufacturers:
 - 1. HVAC Sleeve Seals:
 - a. None
- B. Approved Manufacturers:
 - 1. HVAC Sleeve Seals:
 - a. Metraflex Inc.
 - b. PSI-Thunderline/Link-Seal

2.2 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B32.
 - 1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
 - 2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
 - 3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
 - 4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
 - 5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
- B. Brazing Filler Metals: AWS A5.8.
 - 1. BCuP Series: Copper-phosphorus alloys.
 - 2. BAg1: Silver alloy.
 - 3. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 HVAC SLEEVES

- A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
 - 1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
 - 2. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.
 - 3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.
 - 4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with set screws.

2.4 HVAC SLEEVE SEALS

- A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

2.5 HVAC SPECIALTIES

- A. Grout:
 - 1. Non-shrink, Nonmetallic Grout: ASTM C1107, Grade B.
 - a. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
 - b. Design Mix: 5000-psig, 28-day compressive strength.
 - c. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install HVAC piping as described below, unless piping Sections specifies otherwise. Individual Division 23 Piping Sections specifies unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings as required by Division 01 Sections and as outlined in Part 1 of this section.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- E. Install piping free of sags and bends.
- F. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- G. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- H. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- I. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-

- iron sleeve fittings below floor slab as required to secure clamping rings where required.
 - 2. Build sleeves into walls and slabs as work progresses.
 - 3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 4. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant.
- J. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
 - 3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stopping materials. Refer to Division 07 for materials.
- L. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- M. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - 3. Soldered Joints: Construct joints according to CDA's "Copper Tube Handbook."
 - 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights is not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Owner's Representative.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

- E. Clearance from Electrical Equipment: Piping and ductwork are prohibited in electric rooms and closets, elevator machine rooms and installation over transformers, switchboards and motor control centers.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."
- C. Prime and paint all metal supports per Division 09 requirements similar to "Pipes and Mechanical Equipment".

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage 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 wood members.
- C. Attach to substrates as required to support applied loads.

3.5 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.+++++
- B. Repair cut surfaces to match adjacent surfaces.
- C. Refer to Division 01 Sections for additional requirements.

3.6 GROUTING

- A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.

- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 23 05 00

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Basic Motor Requirements
 - 2. Polyphase Motors
 - 3. Single Phase Motors

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers (IEEE) Publications:
 - 1. 112 "Standard Test Procedure for Polyphase Induction Motors and Generators"
- B. National Electrical Manufacturer's Association (NEMA) Standards Publications:
 - 1. MG 1 "Motors and Generators"
- C. National Fire Protection Association (NFPA) Publications:
 - 1. 70 "National Electric Code"

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
 - 1. Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Listing and Labeling: Provide motors specified in this Section that are listed and labeled.
 - 1. Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 BASIC MOTOR REQUIREMENTS

- A. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.
- B. Motors 1/2 HP and Larger: Polyphase.
- C. Motors Smaller than 1/2 HP: Single phase.
- D. Frequency Rating: 60 Hz.
- E. Voltage Rating: Determined by voltage of circuit to which motor is connected.
- F. Service Factor: According to NEMA MG 1, general purpose continuous duty, design type "B."
- G. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- H. Enclosure: Open drip-proof, unless otherwise indicated.
- I. Efficiency: Motors shall have a higher efficiency rating than industry standard average motor as delineated in IEEE Standard 112, Test Method 13.

2.2 POLYPHASE MOTORS

- A. Description: NEMA MG 1, medium induction motor.
 - 1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
 - 2. Energy-Efficient Design: Where indicated.
 - 3. Stator: Copper windings, unless otherwise indicated. Multi-speed motors have separate winding for each speed.
 - 4. Rotor: Squirrel cage, unless otherwise indicated.
 - 5. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.
 - 6. Temperature Rise: Match insulation rating, unless otherwise indicated.
 - 7. Insulation: Class F, unless otherwise indicated.
- B. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for indicated controller, with required motor leads brought to motor terminal box to suit control method.
- C. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Critical vibration frequencies are not within operating range of controller output.
 - 2. Temperature Rise: Match rating for Class B insulation.
 - 3. Insulation: Class H
 - 4. Thermal Protection: Where indicated, conform to NEMA MG 1 requirements for thermally protected motors.

- D. Source Quality Control: Perform the following routine tests according to NEMA MG 1:
 - 1. Measurement of winding resistance.
 - 2. No-load readings of current and speed at rated voltage and frequency.
 - 3. Locked rotor current at rated frequency.
 - 4. High-potential test.
 - 5. Alignment

2.3 SINGLE-PHASE MOTORS

- A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.
 - 1. Permanent-split capacitor.
 - 2. Split-phase start, capacitor run.
 - 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.
- C. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.
- D. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, pre-lubricated sleeve bearings for other single-phase motors.

PART 3 - EXECUTION

3.1 ADJUSTING

- A. Use adjustable motor mounting bases for belt-driven motors.
- B. Align pulleys and install belts.
- C. Tension according to manufacturer's written instructions.

END OF SECTION 23 05 13

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SECTION 23 05 29

PIPE SUPPORTS, SLEEVES, AND SEALS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Work of this Section includes, but is not limited to:
 - 1. Pipe hanger and supports
 - 2. Pipe and equipment anchors
 - 3. Pipe sleeves

1.2 QUALITY ASSURANCE

- A. Pipe Hanger Standards: Manufacturers Standardization Society MSS SP-58, SP-89, and SP-69, as referenced.
- B. Pipe sleeves shall meet the requirements of ASTM A53, Type E, Grade A, Schedule 40.

1.3 SUBMITTALS

- A. Shop Drawings: Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members.
- B. Product Data: Catalog cuts and performance data.
- C. Samples: Not required for review.
- D. Reference Submittals: Not required for review.
- E. Contract Closeout Information
 - 1. Operating and maintenance data
 - 2. Warranty

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Pipe Hangers: Elcen Metal Products Co., B-Line Systems, Inc., Carpenter and Paterson, Inc., Anvil International.

- B. Insulated Pipe Supports: Pipe Shields, Inc., Buckaroos, Inc., Berger Pre-Insulated Pipe Support Inc., or Value Engineering products.
- C. Pipe and Equipment Anchors
 - 1. Shop-fabricated
 - 2. Field-fabricated
- D. Sleeves
 - 1. Shamrock Industries, "Crete-sleeve" plastic hole forms
 - 2. Proset Systems Inc., "Proset" fire-safe pipe penetrations
 - 3. Shop for field fabricated
- E. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc, ANVIL, Power Piping.

2.2 PIPE HANGERS

- A. General
 - 1. Materials, Design and Manufacture: MSS SP-58
 - 2. Fabrication and Installation: MSS SP-89
 - 3. Selection and Application: MSS SP-69
 - 4. Hangers Used Directly on Copper Pipe: Copper or cadmium-plated
 - 5. All Other Hangers and Channels, Angles, and Supporting Steel: Cadmium-plated or galvanized.
 - 6. All Hanger Rods of Continuous Thread Type: Electrogalvanize or cadmium plate after threads is cut.
 - 7. Galvanize all structural steel, angles, rods, channels, and hardware that are not provided with a rustproof finish.
 - 8. Screw Threads on Hangers and Fittings: Conform to Class 2A and 2B of ANSI B1.1.
- B. Pipe Hangers for Insulated and Bare Pipe
 - 1. Hangers for insulated pipe to be oversized to accommodate insulation, protection shields, and/or saddles.
- C. Pipe Hangers in Other Situations: See MSS-SP-69
- D. Pipe Hangers on Insulated Lines
 - 1. Pipe Sizes 2 in. and Less: Use pipe covering shield to protect insulation.
 - a. Minimum shield length: 12 in.
 - b. Minimum shield thickness: 18 ga.

2.3 PIPE SLEEVES AND SEALANTS

- A. Sleeves - General
 - 1. Sleeve all piping passing through walls, floors, sufficient to allow free movement of piping.
- B. Sleeves, Steel Pipes

1. Use in following locations:
 - a. Fire-rated and smoke-rated construction.
 - b. Structural steel members (when approved by Engineer).
 - c. Floors: Galvanized.
 - d. Concrete walls.
 - e. Mechanical rooms.

- C. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

- D. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
 1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
 2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
 - a. Insulated chilled water and DX lines: Type CS-CW
 - b. Other insulated pipes: Type CS
 3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

- E. Sleeve Sizes
 1. Length: Ends flush with finished surfaces.
 2. Diameter
 - a. Minimum 3 in.
 - b. Minimum 1 in. larger than pipe and pipe insulation.
 - c. In concrete, 1-1/2 in. larger than pipe.
 - d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

- F. Sealants: Seal annular space around piping.
 1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity.
 - a. Provide proper material for each typical application as described by manufacturer.
 2. Acceptable Manufacturers
 - a. Base
 - 1) Dow Corning "Fire Stop"
 - 2) Nelson "Flameseal"
 - 3) 3M "Fire Barrier"
 - 4) Pipe Shields Inc., Model WFB, DFB, or QDFB Series
 - 5) Proset Systems
 3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
 4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

- A. Structural Considerations
 - 1. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
 - 2. Do not attach hangers to steel roof deck.
 - 3. Attach hangers to beams whenever possible.
- B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction.
- C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.
- D. Do not weld to structural steel without special permission of the Engineer. Do not use wooden plugs for any form of fastening.
- E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.
- F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the Engineer.
- G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.
- H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the Engineer. Anchors shall be approved by the Engineer before they are used.

3.2 PIPE HANGERS AND SUPPORTS

- A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Standard Liquid	Steel Vapor	Copper Liquid	Copper Vapor
1/2 - 1 in.	7 Ft.	8 Ft.	5 Ft.	6 Ft.
1-1/4 - 2 in.	7 Ft.	9 Ft.	7 Ft.	9 Ft.
2-1/2 - 3 in.	11 Ft.	14 Ft.	9 Ft.	13 Ft.
3-1/2 - 4 in.	13 Ft.	16 Ft.	11 Ft.	15 Ft.
5 - 6 in.	16 Ft.	19 Ft.	13 Ft.	18 Ft.

- B. Provide a hanger within one (1) foot or less of each horizontal elbow and valves that are above three (3) inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than six (6) feet, provide only one (1) hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

C. Pipe Hanger Loading

1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 in.	610 lb.
1/2 in.	1,130 lb.
5/8 in.	1,810 lb.
3/4 in.	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

D. Trapeze Hangers

- Suspend trapeze hangers from concrete inserts of approved structural clips.
- Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

E. Vertical Pipe Supports

- Support all vertical pipe runs in pipe chases at base of riser.
- Support pipes for lateral movement with clamps or brackets.

3.3 PIPE AND EQUIPMENT ANCHORS

A. Pipe Anchors

- Provide as indicated and required to permit complete installation of system.
- Do not anchor piping to plaster or gypsum wallboard partition walls.
- Provide anchoring devices at locations indicated.

3.4 SLEEVES

- Coordinate location of any opening in structural systems with Engineer and other trade contractors.
- Maintain rating of fire- and smoke-rated construction.
- Set sleeves plumb or level, in proper position, tightly fitted into the work.
- Set all sleeves with ends flush with finished wall and ceiling surfaces.
- Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts.
 - Install firestopping as described in manufacturer's installation instructions.

- F. Seal around all sleeves.
- G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.5 MISCELLANEOUS STEEL

- A. Provide all miscellaneous steel as required to accommodate pipe supports and hangers.
- B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.
- C. All miscellaneous steel to be galvanized steel. Repair galvanized steel at field cuts and connections.

END OF SECTION 23 05 29

SECTION 23 05 53

IDENTIFICATION FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Identifying Devices and Labels

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
 - 1. Product Data: For identification materials and devices.
 - 2. Samples: Of color, lettering style, and graphic representation required for each identification material and device.

1.3 SEQUENCING AND SCHEDULING

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. General: Products specified are for applications referenced in other Division 23 Sections. If more than single type is specified for listed applications, selection is Installer's option.

2.2 IDENTIFYING DEVICES AND LABELS

- A. Lettering: Manufacturer's standard preprinted captions as selected by Owner's Representative.
- B. Access Panel Markers: 1/16-inch thick, engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch center hole for attachment.

- C. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.
 - 1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

PART 3 - EXECUTION

3.1 ADJUSTING AND CLEANING

- A. Relocate HVAC identification materials and devices that have become visually blocked by work of this or other Divisions.
- B. Clean faces of identification devices.

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 airflow within distribution systems, including sub-mains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC.
 - 4. Setting quantitative performance of HVAC. and plumbing equipment.
 - 5. Verifying that automatic control devices are functioning properly.
 - 6. Reporting results of the activities and procedures specified in this Section.
 - 7. Verify performance of package terminal air conditioning units.

1.2 REFERENCES

- A. Associated Air Balance Council (AABC): "National Standards for Testing, Adjusting and Balancing"
- B. Air Movement & Control Association International, Inc. (AMCA): 201, "Fans and Systems"
- C. National Environmental Balancing Bureau (NEBB): "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems"
- D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): "HVAC Systems--Duct Design"

1.3 DEFINITIONS

- A. Adjust: To regulate air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including sub-mains, branches, and terminals, according to design quantities.
- C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

- D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- E. Report Forms: Test data sheets for recording test data in logical order.
- F. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- G. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- H. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- I. Test: A procedure to determine quantitative performance of a system or equipment.
- J. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
- B. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- C. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents Review Report as specified in Part 3 of this Section.
- D. Submittals Examination Report: Prior to the start of duct fabrication, submit 2 copies of the Submitted Examination Report as specified in Part 3 of this Section.
- E. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

1.5 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.
- B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.

2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
 - C. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing standard forms from AABC's "National Standards for Testing, Adjusting and Balancing" or NEBB's "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems".
 - D. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.
 - E. Testing, Adjusting, and Balancing Conference: Meet with the Owner's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location. As a minimum include the following agenda items:
 1. Submittal distribution requirements.
 2. Contract Documents examination report.
 3. Testing, adjusting, and balancing plan.
 4. Work schedule and Project site access requirements.
 5. Coordination and cooperation of trades and subcontractors.
- 1.6 COORDINATION
- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
 - B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.
 - C. Perform testing, adjusting, and balancing after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Contract Documents to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment and submit "Contract Documents Examination Report".

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 3. Examine Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC and equipment controls.
- B. Examine approved submittal data of HVAC systems and equipment including sheet metal duct fabrication shop drawings to ensure that the distribution system is reasonably complete and sufficiently designed to accurately balance the complete building. Submit "Submitting Examination Report".
1. Examine equipment performance data, including fans. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 07 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 05 and 06. Compare this data with the design data and installed conditions.
- C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
1. Examine HVAC systems and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 2. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
 3. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
 4. Examine terminal units to verify that they are accessible and their controls are connected and functioning.
 5. Examine plenum ceilings, utilized for return air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
 6. Examine heat-transfer coils for clean and straight fins.
 7. Examine equipment for installation and for properly operating safety interlocks and controls.
 8. Examine automatic temperature system components to verify the following:
 - a. Dampers, and other controlled devices operate by the intended controller.
 - b. Dampers are in the position indicated by the controller.

- c. Integrity dampers for free and full operation and for tightness of fully closed and fully open positions.
 - d. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - e. Sensors are located to sense only the intended conditions.
 - f. Sequence of operation for control modes is according to the Contract Documents.
 - g. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 - h. Interlocked systems are operating.
 - i. Changeover from heating to cooling mode occurs according to design values.
- D. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

- A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
- 1. Permanent electrical power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are properly located, sized, and securely closed.
 - 4. Verify that smoke and fire dampers are open.
 - 5. Isolating and balancing valves are open and control valves are operational.
 - 6. Access to balancing devices is provided.
 - 7. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section; or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, balancing, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- C. Cut insulation, ducts, for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

- 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 single line diagrams of systems' "as-built" duct layouts and domestic hot water distribution.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling unit components.

3.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

- A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems.
- B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each air-handling unit component.

3. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 4. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
 5. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 6. Adjust fan speed higher or lower than design with the approval of the Owner's Representative. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
- C. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to design airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in sub-mains and branch ducts is unavailable for Pilot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-mains and branch ducts to design airflows within specified tolerances.
- D. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.
- E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 MOTORS

- A. Motors: Test at final balanced conditions and record the following data:
1. Manufacturer, model, and serial numbers.
 2. Motor horsepower rating.
 3. Motor RPM.
 4. Efficiency rating if high-efficiency motor.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.

3.7 CONDENSING UNITS

- A. Verify proper rotation of fans and measure entering- and leaving-air temperatures. Record compressor data.

3.8 HEAT-TRANSFER COILS

- A. Electric-Heating Coils: Measure the following data for each coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperatures at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kW at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.

3.9 TEMPERATURE TESTING

- A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor and outdoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

3.10 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Verify free travel and proper operation of control devices such as damper and valve operators.
- F. Confirm interaction of electrically operated switch transducers.
- G. Confirm interaction of interlock and lockout systems.
- H. Verify main control supply-air pressure and observe compressor and dryer operations.
- I. Record voltages of power supply and controller output. Determine if the system operates on a grounded or non-grounded power supply.

- J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.11 TOLERANCES

- A. Set HVAC system airflow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.

3.12 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of the instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to the certified field report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
- D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of testing, adjusting, and balancing Agent.
 - 3. Project name.
 - 4. Project location.
 - 5. Owner's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of testing, adjusting, and balancing Agent who certifies the report.
 - 10. Summary of contents, including the following:
 - a. Design versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 11. Nomenclature sheets for each item of equipment.
 - 12. Data for terminal units, including manufacturer, type size, and fittings.
 - 13. Notes to explain why certain final data in the body of reports vary from design values.
 - 14. Test conditions for fans and pump performance forms, including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.

- b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air distribution systems. Present with single-line diagrams and include the following:
 - 1. Quantities of outside, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Location of manual volume control dampers.
- F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data: Include the following:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches and bore.
 - h. Sheave dimensions, center-to-center and amount of adjustments in inches.
 - 2. Motor Data: Include the following:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches and bore.
 - f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
 - g. Number of belts, make, and size.
 - 3. Test Data: Include design and actual values for the following:
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- G. Air Handling Test Reports.
- H. Electric Heat Apparatus Test Reports; i.e., duct furnaces, domestic water heaters.
- I. Electric Coil Test Reports; i.e., electric baseboards, electric unit heaters, electric cabinet heaters.
- J. Duct Traverse Reports.
- K. Air Terminal Device Reports; i.e., diffusers/registers/grilles.
- L. Package Terminal Air Conditioning Test Reports; including equipment leveling to ensure condensate is pitched to building exterior.
- M. Instrument Calibration Reports.

3.13 ADDITIONAL TESTS

- A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 05 93

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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.
 - c. 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. Slope outdoor insulation on top of flat surfaces to prevent water pooling.
- H. Keep insulation materials dry during application and finishing. Mineral fiber 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 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. Cut insulation in a manner to avoid compressing insulation to less than 75 percent of its nominal thickness.
- N. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

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

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies.

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. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

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. Ducts in Unconditioned Spaces, in Semiheated Spaces, or Buried:
 - a. Climate Zones 0, 1, 2, 3, 4: R-6.
2. Ducts in Indirectly Conditioned Spaces:
 - a. Climate Zones 0, 1, 2, 3, 4: R-2.
 - b. Return Air Ducts: No insulation required.

C. Relief Air Ducts: No insulation required.

D. Outdoor Air or Combustion Air Intake Ducts:

1. Ducts in Unconditioned Spaces, in Semiheated Spaces, or Buried: No insulation required unless indicated otherwise.
2. Ducts in Indirectly Conditioned Spaces: R-6.
3. Ducts in Conditioned Spaces:
 - a. Climate Zones 0, 1, 2, 3, 4: R-8.

E. 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.

2.3 SEALANTS

- A. 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.

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. 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, and specialties.
- C. Install insulation materials, forms, vapor barriers or retarders, 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. 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.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Cut insulation in a manner to avoid compressing insulation to less than 75 percent of its nominal thickness.
- M. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. 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.

- 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.

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, and Unions:
 - 1. Install insulation over fittings, 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.

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 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.

3.7 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 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.

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.

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.

3.9 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.

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.

END OF SECTION 23 07 19

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pipe and fittings for hydronic piping.

1.2 SUBMITTALS

- A. Action Submittals:
 - 1. Product Data: For each type of the following:
 - a. Pipe.
 - b. Fittings.
 - c. Joining materials.
 - 2. Delegated-Design Submittal:
 - a. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, and foundation walls.
- B. Informational Submittals:
 - 1. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Condensate-Drain Piping: 150 deg F.

2.2 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.
 - 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

- B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.

- 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.3 JOINING MATERIALS

- A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- B. Solvent Cements for CPVC Piping: ASTM F 493. Solvent cement VOC content 490 g/L or less. Adhesive primer VOC content 550 g/L or less.
- C. Solvent Cements for PVC Piping: ASTM D 2564. Primer ASTM F 656. Solvent cement VOC content 510 g/L or less. Adhesive primer VOC content 550 g/L or less.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Condensate-Drain Piping: Type DWV copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping 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 equipment and valve servicing.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Comply with requirements in other Division 23 Sections for identifying piping.
- I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in other Division 23 Sections.

- J. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in other Division 23 Sections.
- K. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in other Division 23 Sections.

3.3 HANGERS AND SUPPORTS

- A. Comply with requirements in other Division 23 Sections for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions and local codes. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

3.4 PIPE JOINT CONSTRUCTION

- A. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.

END OF SECTION 23 21 13

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SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Tubes.
 - 2. Fittings.
 - 3. Joining Materials.
 - 4. Specialties.

1.2 REFERENCES

- A. [ASHRAE](#) 15, "Safety Code for Mechanical Refrigeration."
- B. [The American Society of Mechanical Engineers \(ASME\)](#) Publications:
 - 1. "Boiler and Pressure Vessel Code"
 - 2. B16.22 "Wrought Copper and Copper Alloy Solder Joint Pressure Fittings"
 - 3. B31.5 "Refrigeration Piping and Heat Transfer Components"
- C. [ASTM International \(ASTM\)](#) Publications: (Former American Society for Testing and Materials)
 - 1. B88 "Standard Specification for Seamless Copper Water Tube"
 - 2. B280 "Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service"
- D. [American Welding Society \(AWS\)](#) Publications:
 - 1. A5.8 "Specification for Filler Metals For Brazing And Braze Welding"
- E. [Manufacturers Standardization Society of the Valve and Fittings Industry.](#) (MSS) Publications:
 - 1. SP-69 "ANSI/MSS Edition Pipe Hangers and Supports - Selection and Application"
- F. [Underwriter's Laboratories, Inc. \(UL\)](#) Standards:
 - 1. 207 "Standard for Refrigerant-Containing Components and Accessories, Nonelectrical"
 - 2. 429 "Standard for Electrically Operated Valves"

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
 - 1. Product Data for each valve type and refrigerant piping specialty specified.
 - 2. Refrigerant piping indicated is schematic only. Contractor shall size and design the piping configuration and install the piping, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and conformance with warranties of connected equipment.
 - 3. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.
 - 4. Maintenance data for refrigerant valves and piping specialties to include in the operation and maintenance manual specified in Division 01 Sections.

1.4 QUALITY ASSURANCE

- A. [ASME](#) Compliance: Qualify brazing and welding processes and operators according to [ASME](#) Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- B. Regulatory Requirements: Comply with provisions of the following codes:
 - 1. [ASME](#) B31.5, "Refrigeration Piping."
 - 2. [ASHRAE](#) 15, "Safety Code for Mechanical Refrigeration."
- C. [UL](#) Standard: Provide products complying with [UL](#) 207, "Refrigerant-Containing Components and Accessories, Non-electrical"; or [UL](#) 429, "Electrically Operated Valves."
- D. Listing and Labeling: Provide products specified in this Section that are [UL](#) listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers:
 - 1. Refrigerant Valves and Specialties:
 - a. Henry Pratt Company, Subsidiary of Mueller Water Products, Inc.
 - b. Parker-Hannifin Corporation; Refrigeration & Air Conditioning Division
 - c. Sporlan Valve Company

2.2 TUBES

- A. Use pre-charged tubing where possible.
- B. Soft Copper Tube: [ASTM](#) B280, Type ACR, annealed temper.

2.3 TUBE FITTINGS

- A. Copper Fittings: [ASME](#) B16.22, wrought-copper streamlined pattern.

2.4 JOINING MATERIALS

- A. Brazing Filler Metals: [AWS](#) A5.8, Classification BAg-1 (Silver).

2.5 REFRIGERANT PIPING SPECIALTIES

- A. Moisture/Liquid Indicators: 500-psig operating pressure, 200 deg F operating temperature; forged-brass body, with replaceable, polished, optical viewing window with color-coded moisture indicator, and solder-end connections.
- B. Permanent Filter-Dryer: 350-psig maximum operating pressure, 225 deg F maximum operating temperature; steel shell, and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for compliance with requirements for installation tolerances and other conditions affecting performance of refrigerant piping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Above ground, within Building: Type ACR drawn-copper tubing.

3.3 INSTALLATION

- A. Install refrigerant piping according to [ASHRAE](#) 15.
- B. Basic piping installation requirements are specified in Section 23 05 00 (15050) - "Common Work Results For HVAC."
- C. Install piping in short and direct arrangement, with minimum number of joints, elbows, and fittings.
- D. Arrange piping to allow normal inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- E. Install piping with adequate clearance between pipe and adjacent walls and hangers, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation. Maximum fill: 40%

- F. Insulate suction lines.
 - 1. Do not install insulation until system testing has been completed and all leaks have been eliminated.
- G. Install branch lines to parallel compressors of equal length, and pipe identically and symmetrically.
- H. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
- I. Slope refrigerant piping as follows:
 - 1. Install horizontal suction lines with a uniform slope of 0.4 percent downward to compressor.
 - 2. Install traps and double risers where indicated and where required to entrain oil in vertical runs.
 - 3. Install traps and inverse traps in accordance with the system manufacturer's requirements.
 - 4. Liquid lines may be installed level.
- J. Use fittings for changes in direction and branch connections.
- K. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- L. Reduce pipe sizes using eccentric reducer fittings installed with level side down.
- M. Provide bypass around moisture-liquid indicators in lines larger than 2-inch NPS (DN50).
- N. Install unions to allow removal of solenoid valves, pressure-regulating valves, expansion valves, and at connections to compressors and evaporators.
- O. Install refrigerant valves according to manufacturer's written instructions.
- P. When brazing, remove solenoid-valve coils; remove sight glasses; and remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties. Do not apply heat near bulb of expansion valve.
- Q. Electrical wiring for solenoid valves is specified in Division 16 Sections. Coordinate electrical requirements and connections.
- R. Charge and purge systems, after testing, dispose of refrigerant following [ASHRAE](#) 15 procedures.

3.4 HANGERS AND SUPPORTS

- A. General: Hangers, supports, and anchors are specified in Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment." Provide according to [ASME](#) B31.5 and [MSS](#) SP-69.

- B. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes. Tube sizes are nominal or standard tube sizes as expressed in [ASTM](#) B88.
 - 1. 1/2 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 2. 5/8 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 3. 1 Inch: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 4. 1-1/4 Inches: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 - 5. 1-1/2 Inches: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.5 PIPE INSULATION

- A. Piping insulation is specified in Section 23 07 00 "HVAC Insulation".

3.6 SPECIALTIES APPLICATION AND INSTALLATION

- A. Install permanent filter dryers in low-temperature systems using hermetic compressors, and before each solenoid valve.

3.7 PIPE JOINT CONSTRUCTION

- A. Basic pipe and tube joint construction is specified in Section 23 05 00 - "Common Work Results for HVAC."
- B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent formation of scale.

3.8 VALVE INSTALLATIONS

- A. Install refrigerant valves according to manufacturer's written instructions.

3.9 CONNECTIONS

- A. Electrical: Conform to applicable requirements of Division 26 Sections for electrical connections.

3.10 FIELD QUALITY CONTROL

- A. Inspect and test refrigerant piping according to [ASME](#) B31.5, Chapter VI.
 - 1. Pressure test with nitrogen to 200 psig. Perform final tests at 27-psig vacuum and 200 psig using halide torch or electronic leak detector. Test to no leakage.
- B. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- C. Repair leaks using new materials; retest.

3.11 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

3.12 CLEANING

- A. Before installation of copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

3.13 COMMISSIONING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryer after leak test, but before evacuation.
 - 2. Evacuate refrigerant system with vacuum pump until temperature of 35 deg is indicated on vacuum dehydration indicator.
 - 3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
 - 4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
 - 5. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 6. Complete charging of system, using new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION 23 23 00

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.
- 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 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.

2.3 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. 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.
- D. 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.

2.4 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. 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.

2.5 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.

2.6 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.

2.7 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. 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.
- C. 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.
- D. 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.
- E. 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 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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. Perform test in at least 10% of the ducts in a given system, but perform no less than one test per system.
- C. Duct system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 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. Curtain-type fire dampers.
 - 3. Ceiling radiation dampers.
 - 4. Flange connectors.
 - 5. Turning vanes.
 - 6. Remote damper operators.
 - 7. Duct-mounted access doors.
 - 8. Removable duct sections.
 - 9. Flexible connectors.
 - 10. 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.
- 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. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. 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 CURTAIN-TYPE FIRE 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 DIBD series.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Pottorff.
 - 6. Safe Air – Dowco Products.
 - 7. Vent Products Co., Inc.
- B. Type: Static or dynamic as indicated on Drawings; rated and labeled according to UL 555.
- C. Fire Damper Dynamic Closure Rating: At least 2000-fpm velocity for all sizes and mounting arrangements at 4-inch wg static pressure.
- D. Fire Rating: 1-1/2 or 3 hours as indicated on Drawings.
- E. Mounting Orientation: Vertical or horizontal as indicated.
- F. Frame and Blade Material: Galvanized steel (or stainless steel for aluminum or stainless steel duct).
- G. Frame: Frame roll-formed in gages required by UL listing; with mitered and interlocking corners. Blade lock.

- H. Blades: Roll-formed interlocking curtain blades operated by fusible link and stainless-steel closure spring. Link temperature rating 165 or 212 deg F as indicated on Drawings.
- I. Mounting Sleeve: Factory-installed, galvanized steel in length required for installation. Steel mounting angles. Ends of sleeve act as duct collars for Style A or B. Integral duct collars at ends of sleeve for Style C, CR, or CO.

2.5 CEILING RADIATION DAMPERS

- 1. Ruskin Company CFD series.
 - 2. American Warming and Ventilating.
 - 3. Nailor Industries Inc.
 - 4. Pottorff.
 - 5. Safe Air – Dowco Products.
- B. General Requirements:
- 1. Labeled according to UL 555C.
 - 2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- D. Blades: Galvanized sheet steel with refractory insulation.
- E. Heat-Responsive Device: Replaceable, 165 deg F or 212 deg F rated, fusible links.
- F. Fire Rating: 1, 2, or 3 hours as indicated.

2.6 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.

2.7 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.

2.8 REMOTE DAMPER OPERATORS

- 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. Young Regulator Company.
 - 2. Ventfabrics, Inc.
- B. Description: Cable system designed for remote manual damper adjustment with metal tubing, stainless steel cable, recessed wall or ceiling box, and polished stainless steel box cover.

2.9 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.

2.10 REMOVABLE DUCT SECTIONS

- 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. Langdon Inc.; model Sure-Clamp Access.
 - 2. Approved equal.
- B. Removable duct access section reinforced for duct pressure class of connecting ducts. Flanged duct section secured by clamps with lever latching devices. Gaskets within clamps to seal edges of flanges. Section at least 12 inches long in direction of airflow.

2.11 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.

2.12 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. Where volume damper is installed above a ceiling, provide 18-inch long high-visibility-orange ribbon hanging from damper operator.
- 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 fire or smoke damper according to UL listing.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. Downstream from manual volume damper, control damper, backdraft damper, and equipment.
 - 2. Adjacent to and close enough to fire or smoke damper to reset or reinstall fusible link. Door for access to fire or smoke damper having fusible link shall be pressure relief access door and shall be outward operation for access door installed upstream from damper and inward operation for access door installed downstream from damper.
 - 3. At each control device requiring inspection.
 - 4. Elsewhere as indicated.
- K. Install access door with swing against duct static pressure.
- L. 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.
 - 7. Access doors for fire dampers, smoke dampers, or combination fire and smoke dampers shall not be less than 12 inches by 12 inches. Where the duct size does not allow a door that large, provide a removable duct section located to give

access to the internal damper components. Where duct is insulated, provide removable insulation over removable duct section as well as over clamps.

- M. Label access door to indicate the purpose of the access door.
- N. Install flexible connectors to connect ducts to equipment. If vibrating equipment is internally isolated from casing, provide rigid duct connections.
- O. For fan developing static pressure of 5-inch wg or more, cover flexible connector with loaded vinyl sheet held in place with metal straps.
- P. 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. Operate fire, smoke, and combination fire and smoke damper to verify full range of movement and verify that proper heat-response or smoke-sensing device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operator to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ceiling-Mounted Ventilators.
 - 2. Motors
 - 3. Factory Finishes
 - 4. Quality Control

1.2 REFERENCES

- A. Air Movement & Control Association International, Inc. (AMCA) Publications:
 - 1. 99 "Standards Handbook" (Revised 2003)
 - 2. 210 "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"
 - 3. 300 "Reverberant Room Method for Sound Testing of Fans"
 - 4. 301 "Methods for Calculating Fan Sound Ratings from Laboratory Test Data"
- B. National Electrical Manufacturer's Association (NEMA) Standards Publications:
 - 1. MG 1 "Motors and Generators"
- C. National Fire Protection Association (NFPA) Publications:
 - 1. 70 "National Electric Code"
- D. Underwriter's Laboratories, Inc. (UL) Publications:
 - 1. 486A "Standard For Wire Connectors and Soldering Lugs for Use With Copper Conductors"
 - 2. 486B "Standard for Wire Connectors for Use With Aluminum Conductors"
 - 3. 705 "Standard for Power Ventilators"

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations.
- B. Operating Limits: Classify according to AMCA 99.
- C. Fan Schedule: The following information is described in an equipment schedule on the Drawings.
 - 1. Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

2. Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
 1. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished specialties, accessories, and the following:
- 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 gages and finishes, including color charts.
- F. Dampers, including housings, linkages, and operators.
 1. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
 3. Maintenance data for power ventilators to include in the operation and maintenance manual specified in Division 01 and in Section 23 05 00 "Common Work Results for HVAC."

1.5 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.
- B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
- C. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.
- D. NEMA Compliance: Provide components required as part of fans that comply with applicable NEMA standards.
- E. UL Standard: Provide power ventilators that comply with UL 705.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements. Verify clearances.

- B. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fans have been commissioned.

1.7 COORDINATION AND SCHEDULING

- A. Coordinate the size and location of structural steel support members.
- B. Coordinate the installation of equipment supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers:
 - 1. Ceiling-Mounted Ventilators:
 - a. Loren Cook Company
 - b. Greenheck Fan Corporation
 - c. PennBarry
 - d. Broan-NuTone LLC

2.2 CEILING-MOUNTED VENTILATORS

- A. Description: Centrifugal fans designed for installing in ceiling or wall, or for concealed in-line applications.
- B. Housing: Galvanized steel lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Aluminum, louvered grille or eggcrate with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Variable-Speed Controller Mounted on Fan Housing: Solid-state control to reduce speed from 100 percent to less than 50 percent.
- G. Sound Level: Guestroom Toilets shall have a maximum of 0.3 Sones per HVI 915 Procedure for Loudness Rating of Residential Fan Products – Refer to Light Fixture Matrix for approved manufacturers and models.
- H. Accessories: Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 MOTORS

- A. Refer to Section 23 05 13 - "Common Motor Requirements for HVAC Equipment" for general requirements for factory-installed motors.
- B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- C. Enclosure Type: The following features are required as indicated:
 - 1. Open dripproof motors where satisfactorily housed or remotely located during operation.

2.4 FACTORY FINISHES

- A. Sheet Metal Parts: Prime coat before final assembly.
- B. Exterior Surfaces: Baked-enamel finish coat after assembly.
- C. Aluminum Parts: No finish required.

2.5 SOURCE QUALITY CONTROL

- A. Testing Requirements: The following factory tests are required as indicated:
 - 1. 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." Label fans with the AMCA Seal.
 - 2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the power ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install power ventilators according to manufacturer's written instructions.
- B. Support units using the vibration-control devices indicated. Vibration-control devices are specified in Section 23 05 48 - "Vibration, and Seismic Control for HVAC Piping and Equipment."
- C. Install units with clearances for service and maintenance.

- D. Label units according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.3 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Electrical: Conform to applicable requirements in Division 16 Sections.
- C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, and to report results in writing.

3.5 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Lubricate bearings.

3.6 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.
 - 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive.

END OF SECTION 23 34 23

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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. Airmate
 - 3. Price.
 - 4. Krueger.
 - 5. Nailor Industries Inc.
 - 6. 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. 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 short dimension.
6. Blade Spacing: 3/4-inch.
7. Accessories: Opposed blade damper.

C. 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

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SECTION 23 81 43

AIR-SOURCE UNITARY HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of air-source heat pump outdoor condensing packages:
 - 1. Split system R410A refrigerant based air-cooled heat pump

1.2 SUBMITTALS

- A. Product Data: Include rated capacities for each model; shipping, installed, and operating weights; furnished specialties; and accessories for each type of product specified.
- B. Shop Drawings: From manufacturer, detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For air-source heat pumps to include in the maintenance manuals specified in Division 23.
- D. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain air-source heat pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-source heat pumps and are based on the specific system indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- C. Listing and Labeling: Provide electrically operated equipment specified in this Section that is listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

- D. Test and rate air-source heat pumps according to ARI 320, "Air-source Heat Pumps." Provide ARI certification.
- E. Comply with UL 1995
- F. Comply with AHRI.
- G. Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- H. Comply with the minimum COP/efficiency levels according to ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Buildings."
- I. Comply with NFPA 70.
- J. Comply with safety requirements of UL 559, "Heat Pumps," for duct-system connections.

1.4 COORDINATION

- A. Coordinate installation of equipment supports, and wall penetrations with all trades.

1.5 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Submit a written warranty, executed by the manufacturer, agreeing to repair or replace components of air-source heat pumps that fail in materials or workmanship within the specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering air-source heat pumps that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide air-source heat pumps by one of the following:
 - 1. Trane Co.
 - 2. Bryant
 - 3. Carrier Corp.
 - 4. Goodman

2.2 OUTDOOR CONDENSING UNIT AIR-SOURCE HEAT PUMPS

- A. Description: Factory-assembled and -tested, packaged air-source heat pump suitable for outdoor ambient conditions. Unit has a sealed refrigerant circuit including compressor, condenser and reversing valve; refrigeration and temperature controls; to allow servicing of components in refrigeration circuit.
- B. Energy Efficiency: published AHRI rating as tested shall be as scheduled on drawings. Data for heating shall meet the scheduled HSPF, COP at 47 degrees F and at 17 degrees F; Data for cooling shall meet the scheduled EER, and/or SEER.
- C. Casing: Manufacturer's zinc-coated heavy gauge galvanized-steel casing with the following features:
 - 1. Access panels for inspection and maintenance of internal components.
 - 2. Unit base provisions for forklift handling.
- D. Reversing Valve: Manufacturer's standard control valve designed to be fail-safe in heating position.
- E. Compressor: Variable-speed hermetic scroll compressor installed on vibration isolators and enclosed in acoustically treated enclosure with built-in safeties as follows:
 - 1. High-pressure cutout.
 - 2. High-temperature cutout.
 - 3. Low-temperature cutout.
 - 4. Compressor motor overload protection.
 - 5. Capability to reset compressor lockout circuit at either remote thermostat or circuit breaker.
- F. Refrigerant System Components
 - 1. Suction Gas-Cooled Motor with 10% Voltage Utilization Range of Unit Nameplate Voltage
 - 2. Crankcase Heater
 - 3. Factory Installed Liquid Line Filter Drier.
 - 4. Manufacturer's published Refrigerant Piping maximum equivalent length allowable shall be a minimum of 200 feet for the unit as configured with outdoor unit below indoor unit.
- G. Refrigerant Piping Materials: Drawn-temper, Type ACR copper tube with wrought-copper fittings and brazed joints. Insulate refrigerant gas piping with 3/8-inch thick, flexible elastomeric insulation. Provide weather-proof insulation cover integral to insulation or as field assembled casing. Casing may be PVC or aluminum.
 - 1. Insulation Fire-Performance Rating: 25 flame-spread and 50 smoke-developed rating according to ASTM E 84.
- H. Condenser Components
 - 1. Coil: 3/8" Copper Tube Mechanically Bonded to Lanced Aluminum Plate Fins
 - 2. Fan: Direct Drive, statically and Dynamically balanced.
 - 3. Motor: Permanently Lubricated Totally Enclosed or Open Construction.

- I. Unit Controls: Field-installed, programmable, auto-changeover thermostat, with cool/off/heat system switch, auto/on fan switch, and 7-day programming.
 - 1. Relays: Provide each unit with 2 factory-mounted and -wired relays to facilitate interface with energy management and control systems.
- J. Field Installed Options
 - 1. Low Ambient control to allow operation to Outdoor Ambient temperature of 20 deg F.
- K. Accessories: Provide all accessories listed on drawing schedule.

2.3 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested units before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances, other specific conditions, and other conditions affecting performance of air-source heat pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine piping and electric rough installations for air-source heat pumps to verify actual locations of piping connections before installation.

3.2 INSTALLATION

- A. Install air-source heat pumps according to manufacturer's written instructions.
- B. Install units level and plumb, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

3.3 CONNECTIONS

- A. Piping Connections: Drawings indicate the general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Connect refrigerant piping final terminations to allow full access to unit on all four sides.
- B. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

3.4 CLEANING

- A. Comb Condenser Fins at substantial completion prior to turning systems over to Owner.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of air-source heat pumps, including piping and electrical connections. Report results in writing.
 - 1. Test and adjust controls and safeties.
 - 2. Replace damaged and malfunctioning controls and equipment.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 2. Review data in the maintenance manuals specified in Division 1.
 - 3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 23 81 43

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SECTION 23 82 19

AIR HANDLING UNIT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Fan coil unit and accessories complete with controls.
 - 2. Direct-expansion cooling coils.

1.2 DESCRIPTION OF WORK

- A. Furnish and install units as shown on the Drawings. Performance of units shall be as scheduled or indicated on the Drawings.

1.3 QUALITY ASSURANCE

- A. Capacity: Unit capacities shall be certified under Industry Room Fan Coil Air Conditioner Certification Program in accordance with ARI Standard 440-93.
- B. Safety: All standard units shall be UL- and CSA-labeled and approved.

1.4 SUBMITTALS

- A. Product Data: For each fan coil unit. Include rated capacities of selected models; shipping, installed, and operating weights; furnished specialties; and accessories. Include plan and elevation views of units, minimum clearances, and data on ratings and capacities.
- B. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For each fan coil unit to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Fan coil unit and accessories complete with controls.
 - 2. Direct-expansion cooling coils..
- D. Warranties: Special warranties specified in this Section.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of fan coil unit that fail in materials or workmanship within specified warranty period:
 - 1. Heat exchanger.
 - 2. Control circuit board.
- B. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 FAN COIL UNIT

- A. Manufacturer:
 - 1. Trane
 - 2. Goodman
 - 3. Carrier Corp.
 - 4. Bryant
- B. Cabinet:
 - 1. Galvanized, leather grain-embossed finish
 - 2. Foil-faced insulation covers the entire blower case to reduce operating sound and cabinet condensation
 - 3. Glue-less cabinet insulation retention
 - 4. Screw-less sides & back prevents condensation
 - 5. Multi-position capability: Upftow vertical
 - 6. Coil-mounting track for quick repositioning
 - 7. Tool-less filter access
 - 8. Multiple electrical knockouts
 - 9. Heavy-gauge bottom plate
- C. Finish of External Casings and Cabinets: Factory painted, manufacturer's standard color.
- D. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.
- E. Fan Motors: Energy-efficient type as specified in Division 23 Section "Motors." Open dripproof, with internal thermal protection and permanent lubrication.
- F. Fan Motors: Multi-speed, with internal thermal protection and permanent lubrication.

- G. Coil: All-aluminum.
- H. Internal factory-mounted TXV valve.
- I. Automatic Controls: Solid-state board delays fan start and shutdown.
- J. Accessories:
 - 1. All fan coils shall be shipped complete with coil, pre-wired and ready to install.
 - 2. Electric coil for heat pump back up shall be installed in the fan coil housing.
 - 3. Provide all accessories listed on drawing schedule.

2.3 CONTROLS

- A. Controls: Include components required for satisfactory operation of air handler and auxiliary equipment in all seasons.
- B. Control Transformer: 24-V ac output, factory installed, and wired in air handler.
- C. Cooling Relay: To start condensing unit.
- D. Blower Fan Control: Variable continuous fan-speed control.
- E. Thermostat: Comply with requirements for Heat Pump System Thermostats.

2.4 AIR FILTERS AND CLEANERS

- A. Filters: 1-inch thick, disposable, fiberglass type in sheet metal frame.

2.5 COOLING FEATURES

- A. Evaporator Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Match remote condensing unit specified in Division 15 Section "Condensing Units" with type, capacity, pressure-drop ratings, restricted distributor, or expansion valve. Include condensate drain pan with accessible drain outlet.
- B. Evaporator Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

PART 3 - EXECUTION

3.1 FURNACE INSTALLATION

- A. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

1. Anchor furnace to substrate to resist code-required seismic acceleration.
- B. Controls: Install thermostats at mounting height of 48 inches above floor.
- C. Control Wiring: Install control wiring as specified in Division 26 Section "Control/Signal Transmission Media."
- D. Connect ducts according to Division 23 Section "Metal Ducts."
- E. Install piping adjacent to machine to allow service and maintenance.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.3 CLEANING

- A. After completing installation, clean furnaces internally according to manufacturer's written instructions.
- B. Install new filters in each furnace within 14 days after Substantial Completion.

END OF SECTION 23 82 19

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. QMark; Marley Engineered Products
 - 2. INDEECO
 - 3. Markel Products; TPI Corporation
 - 4. Trane
 - 5. Berko; Marley Engineered Products

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: Built in tamper-resistant thermostat.
- 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. Coordination Between Trades
 - 9. Coordination with Utility Companies
 - 10. Owner Furnished Equipment
 - 11. Materials and Equipment
 - 12. Approved Equals
 - 13. Manufacturer's Declaration
 - 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. Wherever UL compliance is mentioned in the specifications, the above alternative 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. 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.
3. 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 into 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:
 - i. Name, address, and telephone number of servicing agency
 - ii. Names of personnel to be contacted for service arrangements
 - f. Parts list with numbers of replaceable items, including sources of supply
 - g. Manufacturers' literature describing each piece of equipment
 - h. One approved copy of each submittal
 - i. Written warranties
 - j. Certificate of Material Receipt and Certificate of System Completion
 - k. One typewritten directory for each panelboard as installed
 - l. Record (as-built) drawings
 - m. Certificate of Final Inspection signed by Building Authority having jurisdiction
 - n. Test Results
 - o. Coordination analysis (see "Power System Coordination Analysis")
 - p. 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.
- 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.
- B. Division of work-electric power utility
 - 1. In general, the power company will do the following:
 - a. Provide standard 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 transformer primary
 - l. Provide terminal pole and framing
 - 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 guard post
 - 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.
- D. Division of work- – CATV and High Speed Data utility
 - 1. In general, the Cable TV & High Speed Data internet utility company is responsible for all service cable work, including furnishing and installing main service, 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 cable and internet communications service conduits.
 - b. Furnishing and installing cable and internet 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 120volt GFCI double duplex receptacle with integral surge suppression.

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 consideration and possible subsequent inclusion into the bidding documents. Submission must be received a minimum of 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.

2.3 MANUFACTURER'S DECLARATION

- A. Submit a list of the suppliers of Major Equipment to be used on this project. This shall be submitted with the bid. This list shall be typed on company letterhead and shall list the project title. The manufacturer and catalog number/type shall be listed adjacent to each specification section number and product description.

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, bus-way 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 information for openings and holes 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. Insulation leakage and impedances.
 - 3. Ground system resistance.
 - 4. Any sub-system tests described in other Sections of these Specifications.
 - 5. 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 Contractor 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 clearly 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
 - c. Oil Resistant Service Seals
 - d. Corrosive Service Seals
 - e. Explosion Proof 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 OIL RESISTANT SERVICE SEALS

- A. Modular mechanical type oil resistant service seals have stainless steel bolts and nuts with Nitrile rubber sealing element. Seals shall be Link-Seal, Type O.

- B. Sealing plug type oil resistant seals shall be made of Nitrile rubber. Seals shall be by CSD Sealing Systems.

2.7 CORROSIVE SERVICE SEALS

- A. Modular mechanical type corrosive service seals have stainless steel bolts and nuts with rubber sealing element having high resistance to most organic compounds, acids, alkalis and related chemicals. Seals shall be Link-Seal, Type S.
- B. Sealing plug type corrosive service seals shall be made by Viton rubber. Seals shall be by CSD Sealing Systems.

2.8 EXPLOSION PROOF SEALS

- A. Seals shall resist the passage of gasses, vapors, or flames and be UL approved for the application. Materials shall include iron alloy and/or ductile iron. Fill material shall be applied in place, after installation. The following features shall be included:
 - 1. Stainless Steel drain fittings shall be installed in vertical conduit runs to prevent the accumulation of condensate above the seal.
 - 2. Taper tapped hubs to assure grounding continuity.

2.9 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.

2.10 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. Concrete collars around conduit and busway
 6. Emergency generator concrete equipment base
 7. Housekeeping pads

2.11 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.
 3. Plaster Ceilings: 24" x 24", Milcor Style AP with finish material same as ceiling material or Style K, 16 gauge galvanized steel frame with 18 gauge galvanized steel door panel. 24" x 24" and larger panels shall be reinforced, continuous hinge, cylinder lock, prime painting for finish painting to match ceiling.
 4. Acoustical Concealed Spline Ceilings: 24" x 24", Milcor Style AT, 16 gauge steel frame with an 18-gauge steel recessed door panel. 24" x 24" and larger panels shall be reinforced, continuous hinge, 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.
4. Plaster: 24" x 24", Milcor Style K, 16 gauge steel frame with 14 gauge door panel and 22 gauge galvanized casing beads, concealed spring hinges, cylinder lock, prime painted for finish painting with wall.

2.12 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 and cabling 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. Electrical equipment including, but not necessarily limited to load centers, panelboards, meter centers, busway, and motor starter & disconnect 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

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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 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Voltage Drop Calculations: Provide voltage drop calculations for each feeder from the associated meter center to the apartment unit panel served. Provide a tabulated calculation indicating the following information:

1. Name of panel.
2. Source of panel.
3. Voltage.
4. Design load (amps).
5. Overall/actual conductor length.
6. Conductor size.
7. Ground size.
8. Voltage drop (in volts).
9. Voltage drop (% , percent).

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 and 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
 - 4. Type UF
 - 5. Types SE and USE
 - 6. Type SO.
- D. Multiconductor Cable:
 - 1. Type MC metal-sheathed cable, with ground wire.
 - 2. Type MC-PCS, metal-sheathed cable, with ground wire and control wires.
 - 3. Type NM
 - 4. Type SO
 - 5. Type USE with ground wire.

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. IIsco; 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 GENERAL SIZING REQUIREMENTS

- A. Wire sizes shall meet or exceed the overcurrent device ampacity as required by NFPA 70. The minimum conductor size shall be #12 AWG except for control wiring, which may be #14 AWG.
- B. Wire sizes shall be adjusted for voltage drop based on actual length of conductors to be installed. Where shown on the drawings, wire sizes represent the minimum required size and are based on initial design conditions. Verify sizes shown are adequate and provide larger sizes to account for voltage drop as necessary.
 - 1. Feeders: Voltage drop shall not exceed 2% at design load.
 - 2. Branch circuits: Voltage drop shall not exceed 3% at design load.
 - 3. Ground conductors: Proportionally increased as required by NFPA 70.
- C. Ampacity of insulated conductors shall be based on 60°C (140°F) for feeders and branch circuits protected by an overcurrent device rated 100 amps or less, or where terminals are marked 60°C or 60°C/75°C.
- D. Ampacity of insulated conductors shall be based on 75°C (167°F) for feeders and branch circuits protected by an overcurrent device rated greater than 100 amps, and where terminals are marked 75°C or 75°C/90°C.

3.2 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeder Conductors: Copper, solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Aluminum conductors, solid or stranded, shall only be utilized where specifically noted. Minimum size for aluminum conductors shall be No. 4 AWG.
- B. Branch Circuit Conductors: Copper, solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.3 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
 - 3. Type SE
 - 4. Type USE, multiconductor cable
- B. Exposed Feeders may utilize the following:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
 - 2. Type XHHW-2, single conductors in raceway
 - 3. Metal-clad cable, Type MC

- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
 - 2. Metal-clad cable, Type MC
 - 3. Nonmetallic-sheathed cable, Type NM
 - 4. Type SE, with ground wire
- D. Feeders 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
 - 3. Underground feeder cable, Type UF
 - 4. Type USE, with ground wire.
- E. Exposed Branch Circuits, Including in Crawlspace:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
 - 2. Metal-clad cable, Type MC
 - 3. Nonmetallic-sheathed cable, Type NM.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
 - 1. Type THHN-2-THWN-2, single conductors in raceway
 - 2. Metal-clad cable, Type MC
 - 3. Mineral-insulated, metal-sheathed cable, Type MI
 - 4. Nonmetallic-sheathed cable, Type NM.
- G. 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
 - 3. Underground branch-circuit cable, Type UF.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. All feeder and branch circuits shall be provided with dedicated neutral conductors (shared neutrals not permitted).
- C. 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.
- D. 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.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

- F. Install exposed cables parallel or perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-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.

3.6 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.

3.7 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. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, **test service entrance and feeder conductors** for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3

AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

- a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
- b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. 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.

F. 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 ACTION SUBMITTALS

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

1.3 CLOSEOUT 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.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
- B. 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. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- B. 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.
- C. 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. Metallic Fences: Comply with requirements of IEEE C2.
 - 1. Grounding Conductor: Bare copper, not less than **No. 6** AWG.
 - 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 - 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

- D. 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 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.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12 inches deep, with cover.
 - 1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange 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.

- F. 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. 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. 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.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. 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.
- F. 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.

1.3 ACTION SUBMITTALS

- A. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.

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. IMC: Comply with ANSI C80.6 and UL 1242.
1. Not to be used in corrosive atmospheres.
- C. PVC-Coated Steel Conduit: PVC-coated RGC, IMC. Comply with NEMA RN 1. Coating thickness 0.040 inch, min.
1. For use in utility tunnels and other corrosive atmospheres.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
1. For use in utility tunnels and other corrosive atmospheres.
 2. Not to be used in contact with concrete
- E. RTRC Fiberglass: Comply with UL 1684A and NEMA TC 14.
1. For use underground, direct buried or encased in concrete.
 2. For use in utility tunnels or corrosive atmospheres.

- F. 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.
- G. 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.
- H. 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.
- I. 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.
- J. Rigid HDPE: Comply with UL 651A.
 - 1. For use underground, direct buried, or where directional drilling is permitted.
- K. ENT: Comply with NEMA TC 13 and UL 1653.
 - 1. For use with telecommunications cabling and fiber optic cable, indoors where not exposed to physical damage.

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, ARC, and IMC
 - 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. RTRC and 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, insulated throats, concrete tight. Cooper Industries #450 series, or equal.
 - 2. Steel fittings, compression type, insulated throats. Cooper Industries #1600 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. ENT:
 - 1. Comply with NEMA TC 3; match to conduit or tubing type and material.
- J. 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.
- K. 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.
- L. 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 or Flanged-and-gasketed type, unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.6 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect, Prime coated ready for field painting to match installed surface.
 - 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.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
 - 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. Hubbell Incorporated.
 - b. Mono-Systems, Inc.
 - c. Panduit Corp.
 - d. 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. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C. Boxes shall be listed for the application, with the appropriate fire resistance rating. Nonmetallic Outlet and Device boxes shall only be used where approved for use in Part 3 below.
- E. Cast-Metal Outlet and Device Boxes: For use in surface mounted applications. Comply with NEMA FB 1, Type FD, with gasketed cover.
- F. 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.
- G. 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.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square or octagonal by 2-1/8 inches deep. Provide extension rings as required for recessed boxes.
- K. Gangable boxes are prohibited.
- L. 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.
- M. 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: Cast iron, where installed in concrete slab, otherwise sheet metal is acceptable.
 - 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).
 - 4. Shape: Round or rectangular as noted on the Drawings.

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. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Refer to drawings for wiring device quantity and type.
- D. 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. PVC Externally Coated, Rigid Steel Conduits: Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
- B. Install surface raceways only where indicated on Drawings.
- C. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.
- 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. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Conduit shall be run overhead unless specifically shown on drawings to run under the slab.
- J. Conceal raceways within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. 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 or IMC before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. 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.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. 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.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. 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.
- T. 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.

- U. 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.
- V. 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.
- W. 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.
- X. 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.
- Y. 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.
- Z. 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.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- CC. Locate boxes so that cover or plate will not span different building finishes.
- DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

- EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- FF. Nonmetallic Outlet and Device Boxes: Limited to use within dwelling units only where appropriate fire resistance ratings can be maintained.
- GG. 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 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Direct-buried conduit, ducts, and duct accessories.
2. Concrete-encased conduit, ducts, and duct accessories.

1.2 RELATED DOCUMENTS

- ###### **A.**
- Section 26 05 33 "Raceways and Boxes for Electrical Systems" for commonly used electrical conduit types, fittings, and adhesives.

1.3 DEFINITIONS

- ###### **A.**
- Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 INFORMATIONAL SUBMITTALS

- ###### **A.**
- Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft.
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

3.2 EARTHWORK

- A. Restore surface features at areas disturbed by excavation. Re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- C. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.3 DUCT INSTALLATION

- A. Install ducts according to NEMA TCB 2.
- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of **48 inches**, both horizontally and vertically, at other locations unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Installation Adjacent to High-Temperature Steam Lines: Where duct banks are installed parallel to underground steam lines, perform calculations showing the duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- F. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch .
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building using sleeves. Select sleeves to allow adequate annular clear space between pipe and sleeve for installing mechanical sleeve seals. Comply with requirements in Section 078413 "Penetration Firestopping."
- H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- I. Pulling Cord: Install 100-lbf- test nylon cord in empty ducts.
- J. Duct Construction:

1. Excavate trench bottom to provide firm and uniform support for duct bank.
2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
3. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts. Secure separators to earth and to ducts to prevent floating during fill. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
4. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
5. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of **60 inches** from edge of base. Install insulated grounding bushings on terminations at equipment.

K. Concrete Encasement:

1. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
2. Concrete Cover: Install a minimum of 3 inches of concrete cover at top and bottom, and a minimum of 3 inches on each side of duct bank.
3. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
4. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
5. Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
6. Place minimum 6 inches of engineered fill above concrete encasement of duct bank.

L. Direct-Buried Duct Banks:

1. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

- a. Place minimum 3 inches of sand as a bed for duct bank. Place sand to a minimum of 6 inches above top level of duct bank.

- M. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

- N. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.4 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.6 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

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. Instruction signs.
 - 6. Equipment identification labels.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Exposed Raceways:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Concealed Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING."
- D. Snap-Around Labels for Raceways: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action. Provide at all splice or junction boxes and at 30' maximum intervals.
- E. Tape and Stencil for Concealed Raceways Carrying Circuits More Than 600 V: 4-inch-wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends. Provide legend at 30' maximum intervals.

2.2 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.
- C. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide. Provide at each field splice and termination point.

2.3 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16-inch-thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. 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. 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.
- C. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- D. **Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.**
- E. 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. Power transfer switches.
 - b. Controls with external control power connections.
- F. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- G. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for centralized inverters or battery backup power supplies serving emergency lighting loads.
- H. Electrical Service Equipment: Electrical service equipment shall be provided with an equipment label identifying the available fault current at the equipment bus.
- I. 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. Emergency system boxes and enclosures.
 - f. Enclosed switches.
 - g. Enclosed circuit breakers.
 - h. Enclosed controllers.
 - i. Variable-speed controllers.
 - j. Push-button stations.
 - k. Contactors.
 - l. Remote-controlled switches, dimmer modules, and control devices.
 - m. Battery-inverter units.
 - n. Battery racks.
 - o. Monitoring and control equipment.
 - p. UPS equipment.
 - q. ERRS equipment.

END OF SECTION 26 05 53

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SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Time Clock.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

PART 2 - PRODUCTS

2.1 TIME CLOCK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.
2. Paragon Time Controls
3. Emersion Network Power; ASCO Lighting Control
4. NSi Industries LLC; TORK Products.

B. Electronic Time Clock: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Contact Configuration: single pole, single throw (SPST) or as indicated on the drawings.
3. Contact Rating: 20-A ballast load, 120-/240-V ac. Provide inductive load rated contact where shown on drawings to control motor loads.
4. Programs: Minimum, two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
5. Automatic daylight savings time changeover.
6. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Intermatic, Inc.
 - 2. NSi Industries LLC; TORK Products.
 - 3. Leviton
 - 4. Sunrise Technologies
- B. Description: Solid state, with dry contact rated for 1800-VA, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 - 3. Time Delay: Fifteen second minimum, to prevent false operation.
 - 4. Surge Protection: Metal-oxide varistor.
 - 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Industries, Inc.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 4. Watt Stopper.
- 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**.

2.4 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Industries, Inc.; Greengate
 2. Hubbell Building Automation, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Lutron Electronics Co., Inc.
 5. Sensor Switch, Inc.
 6. Watt Stopper.
 7. Steinel Group.
- B. Devices Types: Devices located in stairwells shall be ultrasonic type. All other locations shall be dual-technology (PIR and Ultrasonic) type, unless otherwise noted on drawings or in this specification.
- C. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast/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.

9. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- D. 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 fluorescent or LED at 120 V, 1200-VA fluorescent or LED at 277 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.

2.5 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
 2. Eaton Corporation.
 3. General Electric Company;
 4. Schneider Electric (Square D).
 5. Siemens.
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served.
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250, hinged enclosure with HOA switch installed in the door. All control wiring shall be wired through the automatic control position.

2.6 EMERGENCY SHUNT RELAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Watt Stopper.
 2. Bodine
 3. Cooper Greengate
 4. Lutron

- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

- 1. Coil Rating: 120 or 277V.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **No. 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. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Operational Test: After 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.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within twelve (12) months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two (2) visits to Project during hours coordinated with the Owner's schedule for this purpose.
 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade 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 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

B. Panelboard Schedules: For installation in panelboards, schedule shall reflect as-built conditions.

1.4 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. Keys: Two spares for each type of panelboard cabinet lock.

1.5 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.

1.6 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 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. Panelboards shall not be rated less than indicated on the drawings.

- B. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Panelboards shall not be rated less than indicated on the drawings.
- 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.
 - 8. Hinged Front Cover: Door-in-Door construction where entire front trim hinged to box and with standard door within hinged trim cover.
- D. Phase, Neutral, and Ground Buses:
 - 1. Material: Copper.
 - 2. Neutral bus (where required) shall be supplied separate from ground Bus.
- 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 thermal magnetic trip type.
- 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. GE/ABB
 - 3. Siemens
- B. Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- C. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
- D. Provide AFCI type circuit breakers for circuits serving dwelling units in compliance with NEC 210.12.

2.5 LOAD CENTERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric (Square D), QO Style or comparable product by one of the following:
 - 1. Eaton
 - 2. GE/ABB
 - 3. Siemens

- B. Overcurrent Protective Devices: Plug-on circuit breakers, replaceable without disturbing adjacent units.
- C. Provide AFCI type circuit breakers for circuits serving dwelling units in compliance with NEC 210.12.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state electronic trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

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. Wall mounted load centers in tenant units shall be installed so that the top operable circuit breaker is 4'-0" above the floor. Coordinate load center location to avoid interference with other equipment and comply with ANSI A117.1.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- E. 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.
- F. Install filler plates in unused spaces.

- G. 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.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. 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."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- C. Panelboards will be considered defective if they do not pass tests and inspections.

3.5 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Receptacles
 - 2. Weather-resistant receptacles.
 - 3. Tamper-Resistant receptacles.
 - 4. USB Charging receptacles.
 - 5. Receptacles with integral GFCI
 - 6. Snap switches.
 - 7. Device cover plates.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. AFCI: Arc-fault circuit interrupter.
- C. GFCI: Ground-fault circuit interrupter.
- D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- E. RFI: Radio-frequency interference.
- F. 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, 125 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 Commercial Grade grounding type.
- C. Weather Resistant Receptacles: ultra-violet, corrosion, and impact resistant; with UL approved "WR" marking on face.
- D. Tamper Resistant Receptacles: All 120V and 250V, 15A and 20A, non-locking type receptacles shall be installed in compliance with NEC 406.12. The following locations shall be listed Tamper Resistant:
 - 1. Dwelling units.
 - 2. Offices.
 - 3. Corridors
 - 4. Common areas.
- E. USB Charging Receptacles: Decora style duplex convenience receptacle with two 5VDC, USB Type-A ports with 3.6A of total charging power. Comply with UL 1310 and UL 498.

- F. Specialty receptacles shall be as specified on Drawings.
- G. Plug-Load Control Receptacles: Receptacles shall be permanently marked to visually differentiate them from uncontrolled receptacles.

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.

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. High impact smooth nylon in standard color/finish as selected by Architect and Owner during submittal process.
 - 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.

- 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 up, 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 or local occupancy sensor. Refer to plans for specific control requirements.

3.2 WEATHER RESISTANT RECEPTACLES

- A. All 125 volt, 15 amp and 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 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.
2. Spare-fuse cabinets.

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.
4. Type L: Fuses larger than 600A: Class L, dual element, time delay; 600V – KRP-C.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with **15** percent spare capacity minimum. Provide multiple cabinets if required to meet storage and spare capacity minimums.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high red letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.
 - 5. Keys: Provide (2) two keys for each cabinet provided. Multiple cabinets if provided shall be keyed alike.

2.4 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 **three** 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.
- C. Install spare-fuse cabinet(s). Provide wood blocking secured to studs if mounted on a stud wall.

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).
 - 3. Molded-case switches.
 - 4. Shunt trip switches.

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.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- B. Manufacturer's field service report.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with 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. GE/ABB
 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. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.

4. Ground-fault pickup level, time delay, and I²t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- I. Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 8. Alarm Switch: One NO NC contact that operates only when circuit breaker has tripped.
 9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 10. Zone-Selective Interlocking: Integral with trip unit; for interlocking ground-fault protection function.
 11. Electrical Operator: Provide remote control for on, off, and reset operations.
 12. Accessory Control Power Voltage: Integrally mounted; 120-V ac, unless noted otherwise.

2.4 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 1. Eaton
 2. General Electric
 3. Siemens
 4. Schneider Electric (Square D).

- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
 - 6. Alarm Switch: One NO NC contact that operates only when switch has tripped.
 - 7. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
 - 8. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
 - 9. Electrical Operator: Provide remote control for on, off, and reset operations.
 - 10. Accessory Control Power Voltage: Integrally mounted, 120-V ac, unless noted otherwise.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 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.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to 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. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. 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 enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: 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.

- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 26 28 16

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 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 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/ABB
 - 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/ABB
- 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/ABB
- 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/ABB
 - 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 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 22 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- 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."

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.

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

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SECTION 26 51 19

LED INTERIOR 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 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.
- 1.5 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. 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.
- 1.6 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 interior luminaires in room or module mockups, 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.

1.7 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 PERFORMANCE REQUIREMENTS

- A. Provide Luminaires as scheduled on the Drawings.
- B. Provide luminaires with integral thermal protection.
- C. LED luminaire shall be modular in design with the ability to replace individual components (LED Modules, drivers, etc.) without having to replace the entire luminaire.
- D. All LED luminaire shall have a minimum CRI of 80.
- E. Unless specifically indicated otherwise per the luminaire schedule, all LED lamp CCT shall be 3000K.
- F. LED/LED Module and driver shall be rated for a minimum of 50,000 hours of life at 80% output (LM-80).
- G. For each type Luminaire, the LED/LED Module shall originate from a common manufactured batch source.
- H. All LED/LED Module shall adhere to LED package manufacturer guidelines, certification programs, and test procedures for thermal management.
- I. Driver shall be FCC Part 15 compliant, UL 8750.
- J. Driver shall meet ANSI C62.41 category A surge protection standards up to 4kV.
- K. All LED drivers shall have a power factor greater than 0.90.
- L. Emergency LED battery pack shall be integral mounted, ninety (90) minute capacity, sealed maintenance free nickel cadmium battery and integral charger, operate at rated

lumen output of fixture or next highest lumen output available providing no less than 50% of the standard lumen output, and have remote mountable charging indicator light and test switch. LED drivers shall feature a self-diagnostic circuit that automatically tests unit and reports failure with an audible and visual alarm.

M. Ambient Temperature: Indoor Luminaires, 41 to 104 deg F.; Outdoor Luminaires, 5 to 104 deg F.

1. Relative Humidity: Zero to 95 percent.

2.2 LUMINAIRE REQUIREMENTS

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

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

- a. "USE ONLY" and include specific lamp type.
- b. Lamp diameter, shape, size, wattage, and coating.
- c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

2.3 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT

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.

B. Single-Stem Hangers: 1/2-inch minimum diameter steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 14 AWG. Min.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Regardless of locations shown or mounting heights indicated on drawings, do not rough or install luminaires in locations where they conflict with existing or new equipment. Luminaires that are installed in locations or heights that conflict with the work of other trades, or conflict with the operation or maintenance requirements of equipment shown in the construction drawings shall be relocated as required to resolve such conflicts at the contractor's expense.
- D. Install lamps in each luminaire.
- E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

G. Wall-Mounted Luminaires:

1. Where recommended by luminaire manufacturer, attach to structural members in walls. Otherwise mount fixture to back box.
2. Do not attach luminaires directly to gypsum board.

H. Suspended Luminaires:

1. Ceiling Mount:
 - a. Provide quantity of stems or adjustable aircraft cable to support suspended fixtures as described in the luminaire schedule and manufactures installation instructions.
2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use stems, rod, or aircraft cable support as indicated in luminaire schedule, for suspension of each unit length of luminaire chassis, including one at each end. Maximum span shall not exceed 12'.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid in a minimum of four locations, spaced near corners of luminaire.
4. Do not use ceiling grid as support for luminaires. Support with aircraft cable or similar wire from building structure from a minimum of TWO locations, independent of the ceiling system.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

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. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."
- B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within TWELVE months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to TWO visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 51 19

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SECTION 26 52 13

EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - 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. Product Schedule:

1. For all luminaires and exit signs, use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For luminaires, 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.
 4. Provide seismic qualification certificate for each piece of equipment.
- B. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 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. Lamps: TEN percent of each type and rating installed. Furnish at least one of each type.
 2. Luminaire-mounted, emergency battery pack: FIVE percent emergency lighting units. Furnish at least one of each type.
 3. Diffusers and Lenses: ONE percent of each type and rating installed. Furnish at least one of each type.
 4. Globes and Guards: ONE percent of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

- B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- C. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires and signs 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.
 - 1. Warranty Period: TWO year(s) from date of Substantial Completion.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Power Unit Batteries: FIVE years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
 - 2. Warranty Period for Self-Powered Exit Sign Batteries: FIVE years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.

- E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
 1. Emergency Connection: Operate one lamp or an equivalent number of LED's continuously at an output of no less than 50% of total lumen output upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Indoor Luminaires, 41 to 104 deg F.; Outdoor Luminaires, 5 to 104 deg F..
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 5. Battery: Sealed, maintenance-free, nickel-cadmium type.
 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- F. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
 1. Emergency Connection: Operate one lamp or an equivalent number of LED's continuously at an output of no less than 50% of total lumen output upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 4. Charger: Fully automatic, solid-state, constant-current type.
 5. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the

distance recommended by the emergency power unit manufacturer, whichever is less.

6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Luminaires:
 1. Emergency Luminaires: Drawing designation as indicated in the Luminaire Schedule on Drawings, with the following additional features:
 - a. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations. Indoor and outdoor applications as shown on plans.
 - b. UL 94 flame rating.
- C. Emergency Lighting Unit:
 1. Emergency Lighting Unit: as indicated in the Luminaire Schedule on Drawings.
 2. Operating at nominal voltage matching lighting system.
 3. Wall, ceiling, or stem mounted with universal junction box adaptor.
 4. UV stable thermoplastic housing.
 5. Two LED lamp heads.
 6. Internal emergency power unit.
- D. Remote Emergency Lighting Units:
 1. Emergency Lighting Unit: as indicated on Drawings.
 2. Operating at nominal voltage matching lighting system.
 3. Wall, ceiling, or stem mounted with universal junction box adaptor.
 4. UV stable thermoplastic housing, provide wet location listing where shown outdoors.
 5. LED lamp heads.
 6. External emergency power unit.

2.3 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:

1. Operating at nominal voltage as shown on plans.
2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional battery capacity for power connection to remote units where shown.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

2.5 METAL FINISHES

- ### A.
- Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 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.
- ### B.
- Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

- ### A.
- Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- ### B.
- Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- ### C.
- Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- ### A.
- Comply with NECA 1.

- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and 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.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service:
 1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 1. Inspect all luminaires. Replace signs and luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 26 52 13

SECTION 26 56 13

LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Poles and accessories for support of luminaires.

1.2 DEFINITIONS

- A. EPA: Equivalent projected area.
- B. Luminaire: Complete luminaire.
- C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.
- D. Standard: See "Pole."

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:** For poles to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- B. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.5 WARRANTY

- A. Special Warranty:** Manufacturer agrees to repair or replace components of pole(s) and luminaire-lowering device(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within

a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period: FIVE years from date of Substantial Completion.
2. Warranty Period for Corrosion Resistance: FIVE years from date of Substantial Completion.
3. Warranty Period for Color Retention: FIVE years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 METALLIC POLES

- A. Provide poles made of steel or aluminum, round or square, tapered or straight, as described on plans.
- B. Source Limitations: Obtain poles from single manufacturer or producer.
- C. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties.
- D. Steel Poles: Comply with ASTM A 500/A 500M, Grade B carbon steel with a minimum yield of 46,000 psig. Where designated as stainless steel, comply with ASTM A 240/A 240M with a minimum yield of 55,000 psig. One-piece construction up to 40 feet in height with access handhole in pole wall.
 1. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- E. Aluminum Poles: Seamless, extruded structural tube complying with ASTM B 221, Alloy 6063-T6, with access handhole in pole wall.
 1. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- F. Mast Arms: Provide quantity of arms as described in plans, continuously welded to pole attachment plate. Material and finish same as pole.
- G. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adaptor, then bolted together.
 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.
- H. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- I. Fasteners: Stainless or Galvanized steel type, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- J. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.
- K. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
- L. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.
- M. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Color: As selected by Architect from manufacturer's full range, to match luminaires.

2.3 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

2.4 MOUNTING HARDWARE

- A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi.
1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C or Mechanically deposited galvanization according to ASTM B 695, Class 50.
 2. Bent rods sized per manufacturer's requirements.
 3. Threading: Uniform, Class 2A.

B. Nuts: ASTM A 563, Grade A, Heavy-Hex

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C or Mechanically deposited galvanization according to ASTM B 695, Class 50.
2. Two nuts provided per anchor bolt.

C. Washers: ASTM F 436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C or Mechanically deposited galvanization according to ASTM B 695, Class 50.
2. Two washers provided per anchor bolt.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are 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 EXAMINATION

- A. Examine poles, luminaire-mounting devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
- B. Examine roughing-in for foundation and conduit to verify actual locations of installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE FOUNDATION

- A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Direct-Buried Foundations: Install to depth indicated on Drawings, but not less than one-sixth of pole height. Add backfill in 6-inch to 9-inch layers, tamping each layer before adding the next. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.
- C. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

3.3 POLE INSTALLATION

- A. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
 - 1. Fire Hydrants and Water Piping: 60 inches.
 - 2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
 - 3. Trees: 15 feet from tree trunk.
- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
 - 1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 2. Install base covers unless otherwise indicated.
 - 3. Use a short piece of 1/2 -inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- D. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

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. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. Inspect poles for nicks, mars, dents, scratches, and other damage.
 - 2. System function tests.

END OF SECTION 26 56 13

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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.

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-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
 - 2. Adjustable window slide for adjusting on-off set points.

2.3 LUMINAIRE TYPES

- A. Provide types as indicated in Luminaire Schedule and as indicated on drawings.

2.4 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.

2.5 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.

2.6 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.
- B. Comply with requirements in Section 265613 "Lighting Poles and Standards" for exterior lighting poles and pole bases.

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 BOLLARD LUMINAIRE INSTALLATION:

- A. Align units for optimum directional alignment of light distribution.
 - 1. Install on concrete base. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

- A. Aim as indicated on Drawings.
- B. Refer to details on drawings for mounting orientation and requirements.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 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.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train, Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and any photocell relays.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within the warranty period, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to TWO visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace LED module, driver or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Architect.

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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 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 (whichever 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 with all other Contractors and the Owner, as applicable and necessary to ensure clean, professional looking and operating systems.
- B. 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.
- C. 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

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 systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
6. 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.
7. 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.
8. 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.
9. 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.
10. Avoid running low-voltage cables any closer than 24 inches to any ballast type lighting fixture or other high RF energy producing device.
11. 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.
12. 12" of box or outlet. All cables shall be neatly bundled and secured to discrete cable supports at four-foot intervals.
13. Furnish color-coded cable jackets to identify runs of different systems.
14. Neatly route cables parallel and perpendicular to building architectural lines.
15. Neatly comb out multiple cable bundled runs to remove tangling and crossing of cables within the bundles.
16. 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.
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.

D. 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 labels. 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.
 - c. The nomenclature, color, size, installed location, and type of all labels are subject to the Designer's review and approval.
- E. 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.
- F. 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).
 - 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.
- G. Device Boxes, Pull-Boxes, Junction Boxes
 - 1. Boxes installed in walls and ceilings shall be installed so that the box does not protrude out beyond 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.

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.
 - 3. 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.
 - 4. 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.
 - 5. Neatly cut and drill all openings in walls and floors required for the installation.
 - 6. Cutting and patching shall be held to a minimum by arranging with other Contractors for all sleeves and openings before construction is started.

7. 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.
8. 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.
9. 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, 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.
10. Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, bearing 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. Furnish and set all forms required in masonry walls or foundation to accommodate pipes.

B. General Joint Sealer Application

1. Clean all affected surfaces, joints, etc. immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
2. 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.
3. 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

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SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Hooks.
8. Boxes, enclosures, and cabinets.
9. Polymer-concrete handholes and boxes for exterior underground cabling.

1.2 DEFINITIONS

- A. RMC: Rigid Metal Conduit (see also GRC below).
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RNC: Rigid nonmetallic conduit

1.3 ACTION SUBMITTALS

- A. Product data for the following:
1. Wireways and fittings.
 2. Boxes, enclosures, and cabinets.
 3. Underground handholes and boxes.
- B. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
3. Underground ducts, piping, and structures in location of underground enclosures and handholes.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AFC Cable Systems, Inc.
 2. Allied Tube & Conduit.
 3. O-Z/Gedney.
 4. Robroy Industries.
 5. Southwire Company.
 6. Thomas & Betts Corporation.
 7. Other U.S. Manufacturer
- C. General Requirements for Metal Conduits and Fittings:
 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-D.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: set-screw.
 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

- H. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit.
 - 3. RACO; Hubbell.
 - 4. Thomas & Betts Corporation
 - 5. Carlon.
- C. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- F. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum and riser installation unless otherwise indicated.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alpha Wire Company.
 - 2. Arnco Corporation.
 - 3. Endot Industries Inc.
 - 4. IPEX.
 - 5. Lamson & Sessions; Carlon Electrical Products.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Legrand – Cablofil.
 - 2. Cooper B-Line.
 - 3. Panduit Corp
 - 4. Hoffman.
- C. General Requirements for Metal Wireways and Auxiliary Gutters:
 - 1. Comply with UL 870 and NEMA 250, Type 1 or Type 3R for wet or damp locations unless otherwise indicated, and sized according to NFPA 70.
 - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D.
- D. 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.
- E. Wireway Covers: Hinged type, or Flanged-and-gasketed type for wet or damp locations, unless otherwise indicated.
- F. Finish: Manufacturer's standard enamel finish.

2.5 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Legrand – Cablofil.
 - 2. Cooper B-Line.
 - 3. Panduit
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.
- E. Galvanized or stainless steel.
- F. J shape.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Technologies Company; Cooper Crouse-Hinds.
 - 2. Hoffman.
 - 3. O-Z/Gedney.
 - 4. Quazite:Hubbell Power Systems, Inc.
 - 5. RACO; Hubbell.
 - 6. Thomas & Betts Corporation.
- C. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 - 4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep
 - 5. Audio / Visual Device Box Dimensions: Per equipment manufacturer requirements or as indicated on drawings.
 - 6. Gangable boxes are prohibited.
- D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- F. Metal Floor Boxes:
 - 1. Material: Metal
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. 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.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

2.7 POLYMER-CONCRETE HANDHOLES

- A. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.
- B. Manufacturers: Subject to compliance with requirements, provide products the following
 - 1. Quazite
 - 2. Oldcastle Hartford Concrete Products.
 - 3. EC Babbert

C. General Requirements for Polymer Concrete Handholes:

1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D and SCTE 77.

D. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.

E. Handholes and Manholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

F. All handholes and manholes shall be provided with hardware racking package.

G. All manholes shall be provided with pulling rings, located opposite the conduit entrance on each wall.

H. All hardware shall be corrosion resistant. All steel shall be galvanized, or zinc coated.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: Type EPC-40-PVC.
2. Concealed Conduit, Aboveground: GRC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed, Not Subject to Severe Physical Damage: EMT
 3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
 - a. Mechanical rooms.
 4. Concealed in Ceilings and Interior Walls and Partitions: Free-air with support (Refer to Section 27 05 29).
 5. Damp or Wet Locations: GRC.
 6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway.
 7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, communications-cable pathway.
- C. Minimum Pathway Size: 1-inch trade size communication cables
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use steel, set-screw fittings with insulated throats. Comply with NEMA FB 2.10.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. ANSI/BICSI N1.
 3. TIA-569-E.
 4. NECA 101
 5. NECA 102.
 6. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Provide firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Pathways shall not exceed 40% fill rate at the completion of the project.

- G. Provide conduits in inaccessible environments, including but not limited to above drywall ceilings, in walls, above HVAC ductwork, fume hoods, lab counters and cabinets
- H. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- I. Complete pathway installation before starting conductor installation.
- J. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- K. Provide pull-box for any conduit run that exceeds 100 feet.
- L. LB fittings are not permitted in lieu of pull boxes.
- M. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- N. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- O. Support conduit within 12 inches of enclosures to which attached.
- P. All conduits shall have insulated bushings.
- Q. Conduits for backbone cabling routed to MTR and TR's shall end adjacent in a corner of room where multiple sheets of plywood backboard are installed. Secure conduits to backboard when entering room from above. Extend conduits from below 4 inches above finished floor.
- R. Maintain the following clearances between pathways and possible sources of electromagnetic interference exceeding 5 KVA:
 - 1. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway: 6"
 - 2. Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway: 12"
 - 3. Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways: 24"
 - 4. Electrical motors and transformers: 47"
- S. Raceways Installed Below Slabs:
 - 1. Where pathways are permitted to run below slabs, they should be installed in non-metallic conduit. Provide 6" layer of over fill above conduit.
 - 2. Conduits shall not be installed above the vapor barrier.
- T. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

- U. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- V. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- W. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- X. 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.
- Y. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- Z. Install pull wires in empty pathways. 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. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- AA. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only if indicated on Drawings. No surface pathways are planned for this construction.
- BB. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- CC. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
- DD. Install devices to seal pathway 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 pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- EE. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- FF. Hooks:

1. Hooks are allowed for pathways only above accessible drop ceilings. Do not install above drywall ceilings or in areas with limited access.
 2. Hooks are acceptable as pathways from cable trays to conduit stub-ups located within rooms.
 3. Route hooks to center of room and out to corridor. Do not route hooks along walls.
 4. Minimum clearance between ceiling and hook shall be 6 inches. Do not install hooks more than 18 inches above ceiling.
 5. Shall be supported by dedicated threaded rod supports. Do not use ceiling grid support wire or support rods or supports for other trades.
 6. Hook spacing shall allow no more than 3 inches of slack. The lowest point of the cables shall be no less than 3 inches adjacent to ceilings, and no less than 6 inches adjacent to mechanical ductwork and fittings, luminaires, power conduits, power outlets, and other electrical equipment.
 7. Space hooks no more than 4 feet o.c.
 8. Provide a hook at each change in direction.
 9. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
- GG. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- HH. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- II. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- JJ. 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.
- KK. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- LL. Set metal floor boxes level and flush with finished floor surface.
- MM. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- NN. All pull boxes shall be accessible. Do not place above drywall ceilings, HVAC ductwork or piping.

3.3 FIRESTOPPING

- A.** Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.4 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or 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 27 05 28

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SECTION 27 05 29

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
5. Fabricated metal equipment support assemblies.

1.2 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 the following:
 - a. Slotted support systems, hardware, and accessories.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Equipment supports.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Items penetrating finished ceiling, including the following:

- a. Luminaires.
- b. Air outlets and inlets.
- c. Speakers.
- d. Sprinklers.
- e. Access panels.
- f. Projectors.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. 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. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Galvanized steel. Where installed outdoors or subject to corrosion stainless steel supports shall be provided.
 - 4. Channel Width: Select for applicable load criteria, minimum size 1-5/8 inches.
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 8. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications 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 made of malleable iron.

- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening communication 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 steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are 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 the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. ANSI/BICSI N1
 - 3. TIA-569-D.
 - 4. NECA 101
 - 5. NECA 102.
 - 6. NECA 105.
 - 7. NECA 111.
- B. Provide firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-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, EMT, IMC and RGC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications 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: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Use expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, control enclosures, pull and junction boxes, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 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.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 27 05 29

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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 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. 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.
- f. 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.
- g. 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

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 3 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.

2.2 EQUIPMENT RACKS

A. Wall mount, swing gate type

1. Description
 - a. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - b. Material: 16 gauge steel.
 - c. Four-post: minimum 200lbs load rating.
 - d. Overall height: 50 inches.
 - e. Depth: minimum 22 inches.
 - f. Rack units: 26.
 - 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. Approved Manufacturer: Middle Atlantic CWR Series
 - j. Additional approved manufacturer(s): Great Lakes, Chatsworth, Hubbell.

2.3 RACK ACCESSORIES

A. 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.

B. 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. 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.

4. 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.

B. Rack Accessories

1. Grounding Bus Bar
 - a. Install grounding bus bars in each equipment rack
2. 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

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SECTION 27 11 23

COMMUNICATIONS CABLE MANAGEMENT

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 vertical cable management used within equipment racks.

1.2 SYSTEM DESCRIPTION

- A. The cable management 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 and vertical cable management products used to support and dress cables that land on products mounted to the walls and/or ceilings.
- C. 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 cable management products
 - b. Drawings shall be on 11x17 paper.
 - 2. Communication room(s) wall elevations depicting all of the following:
 - a. Sizes and locations of cable management products
 - b. 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. 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)		
	<i>Basis of Design</i>	<i>Additional Approved Product</i>	<i>Additional Approved Product</i>
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 Channel		INCL	INCL

- 2) 1 Rack Space units:

WIRE MGMT PANEL	WM-A(1RU)		
	<i>Basis of Design</i>	<i>Additional Approved Product</i>	<i>Additional Approved Product</i>
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)		
	<i>Standard of Quality</i>	<i>Additional Approved Product</i>	<i>Additional Approved Product</i>
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 Channel	INCL	INCL	INCL

- 2) 1 Rack Space units:

WIRE MGMT PANEL	WM-B(1RU)		
	<i>Standard of Quality</i>	<i>Additional Approved Product</i>	<i>Additional Approved Product</i>
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

B. 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.

C. 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. 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 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Category 5e twisted pair cable.
 - 2. Category 6 twisted pair cable.
 - 3. Twisted pair cable hardware, including plugs and jacks.
 - 4. Cable management system.
 - 5. Cabling identification products.
 - 6. Source quality control requirements for twisted pair cable.

1.2 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. BICSI: Building Industry Consulting Service International.
- C. EMI: Electromagnetic interference.
- D. IDC: Insulation displacement connector.
- E. LAN: Local area network.
- F. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- G. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- H. RCDD: Registered Communications Distribution Designer.
- I. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- J. S/FTP: Overall braid screened cable with foil screened twisted pair.
- K. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- L. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with the Owner.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 - 1. Horizontal cabling shall be homerun from the MTR /TR to each station outlet. No horizontal cabling shall contain a transition point or consolidation point.
 - 2. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. The maximum allowable horizontal cable permanent link length is 295 feet.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For all cables, include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. Cabling Connectivity Solution warranty. Warranty shall be minimum of 20-years. Warranties provided by cabling partners to cover the system will not be accepted.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
 - 3. Cabling administration Drawings and printouts.
 - 4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.
 - g. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- C. Twisted pair cable testing plan.

- D. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and faceplates for color selection and evaluation of technical features.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For BICSI certified RCDD, listed on the BICSI website with current credentialing, and BICSI certificates for installation technicians, installation supervisor, and field inspector qualifications. Submit copies of all certificates of staff to work on project.
- B. Installation personnel shall consist of 100% BICSI certified staff and listed on the BICSI website. There shall be at least one BICSI certified technician on site during all cable installation.
- C. The Contactor must hold a current certification from the manufacturer of the proposed connectivity solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer's product and applications warranties and specified. All technicians working on the project will have manufacturers training certificates.
- D. Cabling Manufacturers training certificates for each technician.
- E. The cabling testing technician shall be a Fluke Certified Cabling Test Technician, they shall perform all cable testing. Submit copies of certification.
- F. Factory calibration sheets for all testers to be used.
- G. Source quality-control reports.
- H. Product Certificates: For each type of product.
- I. Field quality-control reports.
- J. If installation staff changes during the project, the contractor shall inform the Owner and submit updated information, including all required certificates.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 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. Connecting Blocks: One of each type.
 - 2. Faceplates: Five of each type.
 - 3. Jacks: Ten of each type.
 - 4. Patch-Panel Units: One of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI to supervise on-site testing.
 - 4. Cabling Contractor must have minimum of five years of documented experience installing structured cabling systems.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI as an RCDD on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by Fluke as Certified Cabling Test Technician, or Owner approved equal.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.11 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- 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. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685
 - 2. Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.
 - 3. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Inc. #C6RRB
 - 2. Panduit
 - 3. Belden
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

- D. Conductors: 100-ohm, 23 AWG solid copper, 4-twisted pairs.
- E. Shielding/Screening: Unshielded twisted pairs (UTP)
- F. Cable Rating: Riser.
- G. Jacket: Blue thermoplastic.

2.4 CATEGORY 5e TWISTED PAIR CABLE

- A. Description: Four-pair, unshielded balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 200MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Inc.
 - 2. Panduit
 - 3. Belden
 - 4. Commscope
- C. Standard: Comply with TIA-568-C.2 for Category 5e cables.
- D. Conductors: 100-ohm, 24 AWG solid copper.
- E. Shielding: None. Unshielded twisted pairs (UTP)
- F. Cable Rating: Riser.
- G. Jacket: Blue thermoplastic.

2.5 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Inc.
 - 2. Panduit
 - 3. Belden
- C. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 5e or Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.

- D. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.
- E. Patch Cords: Factory-made, four-pair cables in 12-inch and 120-inch lengths; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.
- F. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Standard: Comply with TIA-568-C.2.
 - 3. Marked to indicate transmission performance.
- G. Jacks and Jack Assemblies:
 - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Designed to snap-in to a patch panel or faceplate.
 - 3. Standard: Comply with TIA-568-C.2.
 - 4. Marked to indicate transmission performance.
- H. Faceplate:
 - 1. Two or Four port, vertical single gang faceplates designed to mount to single gang wall boxes.
 - 2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 3. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
- I. Legend:
 - 1. Machine printed, in the field, using adhesive-tape label.
 - 2. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 270553 "Identification for Communications Systems".

2.7 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

2.8 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified contractor to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.1.
- C. Factory test twisted pair cables according to TIA-568-C.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces in rooms from conduit stub-up to cable tray. Conceal raceway and cables, except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270529 "Hangers and Supports for Communications Systems."

- D. Comply with Section 270536 "Cable Trays for Communications Systems."
- E. Drawings are schematic and indicate general arrangement of pathways and fittings. Exact locations shall be determined by Contractor in coordination with provided system and all other trades.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual , Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
 - 10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 11. In the communications equipment room, install a 10-foot long service loop on each end of cable.
 - 12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.
- E. Separation from EMI Sources:
 1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

3.4 FIRESTOPPING

- A. Comply with TIA-569-D, Annex A, "Firestopping."
- B. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-B and NECA/BICSI-607.

- C. Comply with Section 270526 "Grounding and Bonding for Communications Systems."

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. All labeling requirements shall be coordinated with the Owner prior to implementation.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration.
- C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
 - 1. Label each cable within 6 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. An Owner Representative shall witness all testing. Contract shall schedule testing with The Owner to allow this observation.
- B. Installation of whole system must be complete prior to testing, including pathways, firestopping, all cabling dressed, labeling, devices, and faceplates.
- C. Testing shall be preformed on each cabling segment, connector to connector. Sampling testing is not acceptable.
- D. Permanent link test results, including individual frequency measurements, shall be recorded in the test instrument for subsequent uploading to a PC, using Fluke software or approved equal, from which testing reports shall be generated.
- E. 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.
- F. 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."
- G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports for each tested balanced twisted-pair. Documentation data shall be provided in an electronic database. Include the following information:
 - 1. The overall Pass/Fail evaluation of the link under test
 - 2. The date and time the test.
- J. Acceptance of the test results shall be given in writing after the project is fully completed and the tested in accordance with the Contract Documents and to the satisfaction of the Owner.

END OF SECTION 27 15 13

SECTION 28 13 00

ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Access control system control panel.
 - 2. Access control system network and security.

1.2 DEFINITIONS

- A. CCTV: Closed-circuit television.
- B. Credential: Data assigned to an entity and used to identify that entity.
- C. 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.
- D. LAN: Local area network.
- E. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.
- F. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- G. UPS: Uninterruptible power supply.
- H. USB: Universal serial bus.
- I. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

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..
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. 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.
2. Wiring Diagrams. For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- 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 UL294.

1.6 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.

1.7 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. Linear (Basis of Design: e3 Elite series)
 2. Bosch
 3. Paxton
 4. Honeywell

2.2 DESCRIPTION

- A. Security Access System: IP based access control with card readers, with browser access.

2.3 OPERATION

- A. Security access system shall use a single database for access-control and credential-creation functions.
- B. Browser based access control and management system:
 1. Embedded Linux based operating system.
 2. SQL database.
 3. UL 294 Certified.
 4. Controller with expandable nodes.
 5. Distributed redundant database architecture.
 6. Modules and licenses for doors as shown on drawings plus 10% spare capacity (minimum 1).
 7. 120V power supply
- C. Location:
 1. A system installed at the location shall support up to 128 doors, 256 readers, 20,000 credentials, and up to 120,000 access cards.
- D. System Network Requirements:
 1. System shall communicate via the building's Ethernet or Wi-Fi network.
- E. 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.

F. Operator Interface:

1. System supports the placement of an icon representing an event that may be configured to change the status of multiple objects.

G. 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.

2.4 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. Communication Protocol: Compatible with local processor.
- G. Basis of design: HID Multi-class SE RP40 (or approved equal).

2.5 DOOR INTERFACE

- A. Electrified door hardware: Refer to Architectural Specifications and Drawings for Door Hardware schedules.
- B. Door Contacts:
 - 1. Magnetic contact with standard gap.
 - 2. Hardware-less recess mounting.
 - 3. White heavy duty housing.
 - 4. UL listed for Indoor/outdoor use.
 - 5. Interlogix 1075 or approved equal.
- C. Request-to-Exit:
 - 1. Dual Technology – RCR and PIR.
 - 2. Dual integral Form C relay contacts.
 - 3. Tamper switch.
 - 4. White housing
 - 5. Interlogix RCR-REX or approved equal.

2.6 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 Card Reader 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.
- 2.7 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 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.
 - 1. Comply with requirements in Section 270528 "Pathways for Communications Systems."
- D. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 performance of completed and linked signal paths, end to end.
 - 1. Comply with requirements in Section 271100 "Structured Cabling System."
- E. 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.

- F. 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 27 Section "Grounding and Bonding for Communications."
- 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.

3.6 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. 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.
- C. At completion, cable and asset management software shall reflect as-built conditions.

3.7 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.

3.8 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.

- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 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 per manufacturer's written instructions.
 - 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.10 DEMONSTRATION

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

END OF SECTION 28 13 00

SECTION 28 13 53

NETWORK (IP) INTERCOM SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. IP Video Intercom.

1.2 REFERENCES

- A. American National Standards Institute (ANSI/TIA/EIA) 568 - Commercial Building Telecommunications Cabling Standard.
- B. International Organization for Standards (ISO) 9001:2000 - Quality Management Systems - Requirements.

1.3 SYSTEM DESCRIPTION

- A. IP Network Compatible Video Intercom System: A network-based communication and security system featuring video entry security, internal communication, emergency stations, and paging. All units and app in the systems shall be able to unlock doors remotely on a network, assist onsite visitors from an offsite location, broadcast emergency announcements, and communicate using a PoE network.
 - 1. Power Source: Power over Ethernet (802.3af).
 - 2. Network Interface: 10 BASE-T / 100 BASE-TX Ethernet (RJ-45).
 - 3. Network Protocols: IPv4, IPv6, TCP, UDP, SIP, HTTP, HTTPS, MJPEG, RTSP, RTP, RTCP, IGMP, MLD, SMTP, DHCP, NTP, DNS.
 - 4. Bandwidth Usage:
 - a. G.711: 64Kbps x 2 per video call.
 - b. 64Kbps per monitor.
 - c. H.264: 24Kbps ~ 2,048Kbps.
 - 5. Communication: Hands-free (VOX), push-to-talk (simplex), or handset (full-duplex).
 - 6. Video Display: 7 inch color LCD.
 - 7. Camera: Type:
 - a. 1/3 inch color CMOS. 1.23 Megapixels.
 - b. View Area at 0 degree camera angle mounted at 4 feet 11 inches AFF: 2 feet 3 inches vertical x 3 feet 9 inch horizontal at 19 inches .
 - 8. Video Stream: ONVIF Profile S.
 - 9. Door Release: Programmable Form C dry contact, 24V AC/ DC, 500mA (use RY-24L for larger contact rating, which requires 24V DC power supply) or use IXW MA with 4 4 contact inputs and 10 relay outputs.
 - 10. Wire Type: CAT-6.
 - 11. Distance:

- a. Any station to Network Node: 330 feet.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Shop Drawings: Submit the following:
 - 1. Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.
 - 2. Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
- C. Installation and Operation Manuals:
 - 1. Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
 - 2. Provide detailed information required for Owner to properly operate equipment.
- D. Warranty: Submit manufacturer's standard warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001:2015 certified company.
- B. Installer Qualifications: Factory trained and experienced with system installations of scope and size required for the Project.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship is approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

1.6 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 indoors in accordance with manufacturer's instructions.
- C. Handling: Protect materials during handling and installation to prevent damage.

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Aiphone Corp.,
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.
- C. Basis of design: IX Series 2 Intercom System as manufactured by Aiphone Corporation.

2.2 SYSTEM DESIGN

- A. Master Station(s): IX-MV7-H
- B. Audio Video Door Stations:
 - 1. Model IX-DVF (Video Door Station - Flush Mount - Hands Free) Station locations as per plans.
 - 2. Model IX-DVF-P (Video Door Station - Flush Mount - Hands Free) Station location as per plans.
- C. Provide Selective Door/Gate Release.
- D. Provide Audio/video streaming via ONVIF Profile S.
- E. Provide ONVIF Profile S camera input (max 500).
- F. Provide Overhead paging.
- G. Provide Contact input at door station.

2.3 FUNCTIONAL COMPONENTS:

- A. Functional Components: As indicated on the drawings or as required to complete system.
 - 1. Video Master Station Series:
 - a. Model IX-MV7-H Color selection by Owner.
 - b. Model IX-MV7- Color selection by Owner.
 - c. An IP addressable video master station with a 7 inch color LCD monitor. It can be wall or desk mounted (desk stand included). The IX-MV7 offers handset (duplex) and hands-free (VOX/PTT) communication and call up to 500 other IX stations. It connects directly to a network using CAT-6 cable. This station requires a 802.3af compliant Power-over-Ethernet network.

2. IXW-MA IP Programmable Relay Adaptor: Multi-purpose adaptor - PoE - screen only:
 - a. 4 contact inputs and 10 relay outputs (compatible with IX Series).
3. Network Paging Adapter Model IX-PA:
 - a. Address book that supports up to 50 stations and can be connected to 3rd party devices. Can be accessed by an IX-MV7 master station or an instance of the IX Mobile App to allow messages to be broadcast through the IX-PA 600u or 8u output. A 3rd party device can be connected to the audio input to send messages to the paging adaptor address book.
4. Stainless Steel Security Lock Box Model LB-SDVF.
5. Electric Door Strike Model EL-12S:
 - a. The door strike is designed for wood framed wooden doors. The unit operates on 12~16 V AC.

2.4 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 271100 "Structured Cabling System."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive integrated security and communication system.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

- A. Verify the following compliance before starting installation.
 1. The unit turns inoperative during power failure.
 2. Keep the intercom wires at least 1 foot (30 cm) away from strong electrical wiring (AC 100-240 V) including, in particular, wiring for inverter electrical appliances. Noise and malfunction could result.

3. If a strong light shines on the main unit screen, the picture may turn white or only silhouettes will be visible.
4. Other manufacturer's devices (such as sensor, detectors, door releases) used with this system, comply with the manufacturer's installation requirements.
5. The LCD panel is manufactured with very high precision techniques, inevitably will have a very small portion of its picture elements always lit or not lit at all. This is not considered a unit malfunction. Please be aware of this in advance.

3.3 INSTALLATION

- A. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.4 SET-UP AND ADJUSTING

- A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION AND TRAINING

- A. Demonstration:
 1. Demonstrate that integrated security and communication system functions properly.
 2. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Instruction and Training:
 1. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
 2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
 3. Provide instruction and training by qualified representative of manufacturer.

3.6 PROTECTION

- A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION 28 13 53

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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. FTP: File transfer protocol.
- B. IP: Internet protocol.
- C. LAN: Local area network.
- D. MPEG: Moving picture experts group.
- E. PC: Personal computer.
- F. PTZ: Pan-tilt-zoom.
- G. TCP: Transmission control protocol - connects hosts on the Internet.
- H. 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 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.
 - 1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.5 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. A 6 MP IP video camera, with multi-streaming (H.264, H.265 and MJPEG) capability in IP66/IK10 rated dome housing.
 - 2. Video Compression and Transmission – The 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 and H.264 – frame rates up to 30 fps (60Hz) / 25fps (50Hz) at all resolution.
 - 2) MJPEG – frame rates up to 15 fps(60Hz) / 12fps (50Hz) at all resolution.
3. The 6 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. 16:9 aspect ratio: 3328x1872, 3072x1728, 2688x1520, 1920x1080, 1280x720, 800x448, 640x360
 - b. 4:3 aspect ratio: 2592x1944, 1600x1200, 1024x768, 800x600, 640x480, 320x240
 - c. 5:4 aspect ratio: 1280x1024, 720x576
 - d. 3:2 aspect ratio: 720x480
5. The camera shall support unicast video streaming up to 20 users.
6. The camera shall support multicast video streaming up to 10 profiles.
7. Dynamic DNS (DDNS) support
8. Camera – The 6 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 at F1.2 in color mode and 0 lux in black and white mode with IR LED on.
 - d. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range.
 - e. 2D and 3D digital noise reduction
 - f. Integral IR illumination, providing effective of 40m (131.23 ft) at 0 lux when activated in black and white mode.
 - g. Configurable a privacy masking regions utilizing 4 point polygon.
 - h. The camera shall provide video display on smart phone (iPhone, Android) to adjust viewing angle, rotation and focus.
9. Intelligence and Analytics – The 6 MP camera shall have a suite of integral intelligent operations and analytic functions to include:
 - a. Motion detection with eight definable detection areas, with eight polygonal zones, and minimum/maximum object size.
 - b. Detection of logical events of specified conditions from the camera's video input
 - 1) Defocus detection
 - 2) Fog detention
 - 3) Direction detention
 - 4) Motion detection
 - 5) Digital auto tracking
 - 6) Appear/Disappear
 - 7) Audio Detection
 - 8) Enter/Exit
 - 9) Loitering
 - 10) Tampering
 - 11) Virtual line
 - 12) Audio detection

- 13) Sound classification
 - 14) Shock detection
 - 15) Face/upper body detection
 - c. Business Intelligence features
 - 1) People counting
 - 2) Queue management
 - 3) Heatmap
 - d. Detection and classification of the following sound:
 - 1) Scream
 - 2) Gunshot
 - 3) Explosion
 - 4) Crashing glass
- 10. Interoperability – The 6 MP camera shall be ONVIF Profile S / G compliant.
- 11. The 6 MP camera shall possess the following further characteristics:
 - a. Built-in web server, accessed via non-plugin browsers including Google Chrome, IE11, MS Edge, Mozilla Firefox and Apple Safari.
 - b. Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals
 - c. The camera shall provide streaming to multiple smart phones with DDNS provided freely from the manufacturer. In addition, the application shall be available for both iOS and Adroid, free of charge with search keyword, 'Wisenet Mobile'.
 - d. NAS recording option with configurable pre-alarm and post-alarm recording intervals.
 - 1) Alarms and notifications
 - a. alarm notification triggers:
 - i. Analytics
 - ii. Network disconnect
 - iii. Alarm input
 - 2) Available notification means upon trigger:
 - i. File Upload via FTP and E-mail
 - ii. Notification via E-mail
 - iii. Local storage (SD / SDHC / SDXC) or NAS recording at event triggers
 - iv. Alarm output
 - v. Handover
 - vi. Audio playback
 - e. Pixel Counter available in the web viewer.
 - f. PoE capable.
- 12. Basis of Design: Hanwha XNV-8082R (or approved equal)

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 30 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, 640 x 480, 640 x 360, 320 x 240
 - 4. The camera shall support unicast video streaming up to 10 users.
 - 5. The camera shall support multicast video streaming up to 10 profiles.
 - 6. The camera shall be able to configure Dynamic DNS (DDNS). DDNS shall be provided with no additional cost by the manufacturer.
 - 7. The multi-directional camera shall provide smart codec (WiseStream, 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. True day/night operation with removable IR cut filter
 - a. Low light level operation to 0.008 lux at F2.2 in color mode and 0.008 lux in black and white mode.
 - 4. The camera shall be able to produce clear images in highly contrast scenes with multi-exposure wide dynamic range up to 120dB.
 - 5. The camera shall support digital noise reduction using both 2D and 3D noise reduction technology.
 - 6. The camera shall be able to configure 32 privacy masking area with polygonal.
 - 7. The multi-directional camera shall be able to capture high contrast scenes with 120 dB multi-exposure wide dynamic range.
 - 8. The camera shall provide video display on smart phone (iPhone and Android) to adjust viewing angle, rotation and focus.
 - 9. One touch (Simple) or manual focus controllable remotely via network. The camera shall have motorized varifocal lens.
 - 10. 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.
 - 11. The camera shall support Pan/Tilt/Rotate through Remote adjustment by 200 cycles.
- D. Intelligence and Analytics – The multi-directional camera shall have a suite of intelligent analytic functions.
 - 1. Motion detection with 8 definable detection areas with 8 polygonal zones, and minimum/maximum object size.

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. virtual line
 - g. enter/exit
 - h. appear/disappear
- E. Interoperability – The multi-directional camera shall be ONVIF Profile S and 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 and Apple Safari.
 2. Micro SD/SDHC/SDXC memory card options, 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 (SD/SDHC/SDXC card)
 - 4) external output
 - 5) Pixel Counter available in the plug-in web viewer
 4. HPOE capable.
 5. Basis of Design: Hanwa PNM-9084QZ (or approved equal)

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. Features:
 1. Data Storage: Up to 42TB raw storage
 2. Solid state hard disk drive for Windows operating system
 3. 470 Mbps of recording throughput
 4. SSD & 24/7 Duty Cycle SATA Drives
 5. Network interface: 2 x RJ Gigabit Ethernet
 6. 1 x Intel Xeon Processor
 7. 16GB, 2 x 8GB DDR4 memory
- B. Basis of Design: Wisenet WISE WRR-P-E200x1 (or approved equal)

2.6 VIDEO MANAGEMENT SOFTWARE (VMS)

- A. Description:
 1. The specified product shall be an open video platform designed for use in any video application.
 2. The specified software shall include, free of charge, any API or SDKs necessary to integrate 3rd party devices and systems
- B. The specified software shall include, free of charge, any API or SDKs necessary to integrate 3rd party devices and systems. VMS Software Components:

1. The System shall be comprised of four (4) applications which work together seamlessly.
 - a. Cloud – a cloud application that enables simple remote connectivity, viewing, and management of an unlimited number of systems and users.
 - b. Server – a media server responsible for discovering, connecting to, and managing system users, devices, and associated data.
 - c. Desktop- a desktop application capable of acting as a stand-alone media player or as a client application for connecting to and managing systems.
 - d. Mobile – a mobile application for iOS and Android devices that allows users to connect to, view, search, and control IP cameras over WIFI or Data networks.

C. VMS System Architecture

1. The VMS shall have a Server Hive Architecture wherein:
 - a. All servers in a system are equal and synchronize system databases in real-time
 - b. A user can connect to any system server to see and manage the entire system.
 - c. Servers support automatic camera failover to ensure limited loss of video recording in the event of hardware or network failure.
 - d. Servers will use a SQLite - a free database technology - included in the installation package.
2. The VMS shall support one-click system wide updates.
 - a. System Administrators shall be able to upgrade an entire system via a single button in the Desktop Application.
 - b. System Administrators shall be able to upgrade on demand to the latest release or specific builds with specific functionality or bug fixes.
 - c. System Administrators shall be able to apply an OTA (over-the-air) update.
 - d. Systems Administrators shall be able to generate a URL to download a portable system- specific update package in .zip file format which can be used to update servers without an active Internet connection.
3. The VMS will use secure technologies for inter-application communication and security.
 - a. OpenSSL for network connections - deprecated and insecure protocols and use only TLS v1+.
 - b. Server to Client (Mobile, Desktop, Web) Communications- Option to force encryption between Client and Server for API data.
 - c. Option to force HTTPS video traffic encryption between Client and Server.
 - d. HTTPS Email notification - TLS / SSL - TLS is the default option for Email Server communications.
 - e. Salted/Hashed Passwords - Local Credentials will be protected using a salted MD5 hash, Cloud Credentials should use a complex multi-level hash.
4. The VMS will not require any licenses to increase the number of supported devices, users, or servers.
5. The system shall support scaling to support the maximum recommended system sizes shown below. The system shall support exceeding these recommended maximums by consulting with engineering support.

- a. The system shall support a maximum of 100 Servers in a system.
- b. The system shall support a maximum of 10,000 resources in a system.
- c. The system shall support a maximum of 1,000 concurrent users in a system.

D. VMS Server Application

- 1. The VMS Server application shall be able to run on any of the following operating systems: Microsoft Windows, Ubuntu Linux, NVIDIA Jetson Support.
- 2. The VMS Server application will be capable of operating on any hardware able to run a compatible operating system.
- 3. The VMS Server will be capable of recording 128 dual-streaming IP cameras (256 streams) on a single core of an Intel Core i3 processor.
- 4. Features
 - a. The VMS Server Application shall automatically discover, stream, and record any ONVIF Profile S IP camera located on the same subnet as the server application.
 - b. The VMS Server Application shall manually discover, stream, and record RTSP, HTTP, or UDP (multicast, unicast) streams.
 - c. The VMS Server application shall support up to 1000 concurrent TCP connections
 - d. The VMS Server application shall record and stream video of any resolution and frame rate, limited only by hardware.
 - e. The VMS Server application shall support automatic camera failover without any additional licenses.
 - f. The VMS Server application will support an unlimited number of users and custom user roles.
 - g. The VMS Server application shall support any type of storage medium - HDD's, SSD's, SD cards, DAS, NAS, or other network-attached storage devices or locations.
 - h. The VMS Server application shall support LDAP / Active Directory / Open LDAP integration for user login credential management
 - i. The VMS Server application shall record and stream H.264, H.265, and MJPEG streams.
 - j. The VMS Server application shall record and stream AAC, PCM (Mu-Law, A-law), g726, and MP3 audio.
 - k. The VMS Server application shall transcode streams on demand for delivery to 3rd party systems or devices in H.265, H.264, MJPEG or WebM codecs.
 - l. The VMS Server application shall be able to provide pass-through high or low-res HLS streams from connected devices.
 - m. The VMS Server application shall store archive indices in the same location as recorded video files.
 - n. The VMS Server application shall allow system administrators to recover archives from any storage medium using a re-index archive feature.
 - o. The VMS Server application will contain a boolean events engine allowing operators to program and trigger system actions based on system, connected device, or HTTP events sent from 3rd party system or device.
 - p. The VMS Server application shall be able to send HTTP PUT or GET requests to 3rd party systems or devices.
 - q. The VMS Server application shall support IPv4 or IPv6 addressing.

- r. The VMS Server application shall allow operators to set custom network routing configurations for system servers to optimize network routing and usage.
- s. The VMS Server application shall allow operators to monitor the CPU, RAM, NIC, and HDD usage in real time.
- t. The VMS Server application shall track all operator actions to allow audits
- u. The VMS Server application shall generate automatic crash files every time there is an unexpected crash of the Server application.
- v. The VMS Server application shall allow operators to change the size of reserved disk space for storage drives.
- w. The VMS Server application shall automatically disable any system drive (drive containing the operating system) in computing hardware with more than one drive to ensure the operating system drive does not become full.
- x. The VMS Server application shall support configuration and events from binary I/O contacts on supported devices - including IP cameras and I/O devices.
- y. The VMS Server application shall support sending email notifications via SMTP using TLS, SSL or unsecured connections.
- z. The VMS Server application shall support scheduled backup of recording archives to local, networked, or cloud storage locations.
- aa. The VMS Server application shall allow on-demand backup of recording archives to local, networked, or cloud storage locations.
- bb. The VMS Server application shall allow concurrent-recording of all connected cameras / streams to two (2) servers in real-time.
- cc. The VMS Server application will allow server-side, CPU-based motion analysis for all connected IP cameras with no perceptible increase (<3%) in CPU usage.
- dd. The VMS Server application will require no dedicated GPU in order to perform at maximum capacity.
- ee. The VMS Server application will have a web administration interface that allows users to view live or recorded video from a single camera at a time in high or low resolutions.
- ff. The VMS Server application will have a web administration interface that allows system administrators to view real-time server health monitoring statistics (CPU, NIC, and HDD usage).
- gg. The VMS Server application will have a web administration interface that allows operators to cloud merge two systems together or disconnect the VMS Server from the VMS cloud application.
- hh. The VMS Server application will have a web administration interface that allows users to view all available servers in the system.
- ii. The VMS Server application will have a web administration interface that allows operators to switch between server interfaces.
- jj. The VMS Server application will have a hidden advanced page that gives system administrators the ability to modify advanced system settings.
- kk. The VMS Server application will support any RAID configuration of storage medium

E. VMS Desktop Application

1. Supported Operating Systems: Microsoft Windows, Ubuntu Linux, Apple/Mac.

2. The VMS Desktop application will be capable of operating on any hardware able to run a compatible operating system with a CPU that supports OpenGL 2.1 and Intel HD Graphics3000 (or higher).
3. The VMS Desktop application shall not require any dedicated graphics drive to work at full capacity (64 streams on a 64 bit OS) and shall use the CPU for all video decoding and rendering.
4. Features:
 - a. The VMS Desktop Application will have the following basic structure:
 - 1) Navigation Panel - with a main menu button, an interactive cloud-login icon, tabbed layouts, minimize and maximize icons, a contextual help icon, and a close application icon.
 - 2) Resource Panel (Left) - contains all system resources (Servers, Devices, Users, Layouts, Offline files, etc.) with collapsible structure and a keyword search mechanism to allow operators to quickly search for a display live streams / cameras, offline video and image files, or any combination thereof.
 - 3) Notifications Panel (Right) - shows all system or rules-engine generated notifications which can be clicked on to display relevant resource in the Viewing Grid
 - 4) Timeline Panel (Bottom) - allows for navigation and search of recorded video files
 - 5) Viewing Grid (Main Viewing Area) - a flexible adaptive grid interface which allows operators to create and share customized layouts of system resources.
 - b. The VMS Desktop application shall allow operators to view and interact with the following types of media:
 - 1) Live Streams: H.265, H.264, MJPEG
 - 2) Offline Media: AVI MKV MP4 MOV TS M2TS MPEG MPG FLV WMV 3GP JPG PNG GIF BMP TIFF
 - 3) I/O Devices: Status and Triggers
 - 4) Servers: Real-Time Server Health Monitoring Status
 - c. The VMS Desktop application shall allow the operator to scroll to zoom in to any part of the Viewing Grid.
 - d. The VMS Desktop application shall allow operator to drag & drop to reassign cameras from one server to another server.
 - e. The VMS Desktop application will have a flexible timeline that allows operators to view the dates of any and all archived video in the System for a specific camera, or groups of cameras.
 - f. The VMS Desktop application will allow operators to manually create bookmarks - with a start time, end time, name, description, and tags - for later search. Bookmarks shall also be able to be created using the Rules engine.
 - g. The VMS Desktop application shall allow operators to create Soft Triggers - programmable, customizable buttons which sit on top of streams in the Viewing Grid - to trigger any available system action.
 - h. The VMS Desktop application shall have icons located on the top of live camera streams which allow operators to dewarp fisheye cameras, control PTZ cameras, apply client-side image enhancement, execute smart motion search, create zoom windows, rotate items to any orientation, and activate stream or file info.

- i. The VMS Desktop application shall allow operators to create Zoom Windows (up to 63 zoom windows on a single item in a 64 bit OS) - a magnified view of a part of a live stream, recorded videos, or static images.
- j. The VMS Desktop application shall allow operators the ability to execute a Smart Motion search by selecting a subset of a live camera stream with results shown in red on the flexible timeline. Smart Motion search should be able to search a year (12 months, 365 days) of archived video in less than one (1) second.
- k. The VMS Desktop application will allow users to search live cameras by name, manufacturer, IP address, MAC address, and status (e.g. live).
- l. The VMS Desktop application shall allow operators to search video archives by date and time with a responsive, adaptive timeline.
- m. The VMS Desktop application will allow operators to customize the background image of the application with supported image types.
- n. The VMS Desktop application will support digital mapping by allowing operators to add and customize background images - including opacity and number of grid points.
- o. The VMS Desktop application will utilize adaptive scaling technology to automatically switch between high and low resolution streams during live and recording playback to optimize CPU and network usage.
- p. The VMS Desktop application will allow operators to log in to the Cloud application in order to quickly connect to any shared system.
- q. The VMS Desktop application will allow operators to quickly switch between previously connected or cloud-accessible systems using searchable tiles that show system name and status.
- r. The VMS Desktop application will have a Storage Analytics feature allowing operators to analyze storage capacity of the system based on available drives and real-time and historical bandwidth analysis.
- s. The VMS Desktop application will allow management and configuration of all System devices, users, and resources in a single unified interface.
- t. The VMS Desktop application will allow fast-forward and fast-reverse of archived video up to 16x normal speed.
- u. The VMS Desktop application will show operators which system server they are connected to.
- v. The VMS Desktop application will allow operators to connect to previous versions by automatically downloading and switching to compatible versions.
- w. The VMS Desktop applications will automatically discover available systems on the same network as the computer running the Desktop application.
- x. The VMS Desktop application will automatically recover and reconnect to a system in the instance the server the operator is connected to becomes inaccessible for any reason.
- y. The VMS Desktop application will allow operators to show or hide adaptive thumbnails in the timeline panel.
- z. The VMS Desktop application will allow operators to synchronize all items on a layout or disable synchronization to view live and recorded video at the same time.
- aa. The VMS Desktop application will have adaptive settings dialogs, allowing operators to switch dialog content while the dialog is open by clicking on a resource.

- bb. The VMS Desktop application will allow batch configuration of camera recording schedules, fps, and quality.
- cc. The VMS Desktop application will allow operators to drag and drop multiple system resources onto the Viewing Grid at the same time.
- dd. The VMS Desktop Application will allow administrators to modify time synchronization settings for the system to utilize online resources (NTP servers) or to set a dedicated local time server.
- ee. The VMS Desktop Application will allow system administrators to view a full list of system cameras and devices in a single dialog.
- ff. The VMS Desktop application will allow operators to view, search and export all system events.
- gg. The VMS Desktop application will allow operators to view, search and export all system bookmarks.
- hh. The VMS Desktop application will allow operators to view, search, and export system logs.
- ii. The VMS Desktop application will allow operators to view, search, and export an audit trail of all operator actions and replay related video.
- jj. The VMS Desktop application will allow administrators to backup and restore the system database.
- kk. The VMS Desktop application will allow administrators to create an unlimited number of custom user roles.
- ll. The VMS Desktop application will allow administrators to create and share lockable layouts.
- mm. The VMS Desktop application will allow administrators to update layouts in real time.
- nn. The VMS Desktop application will allow users to record their screen in full resolution and up to 30fps.
- oo. The VMS Desktop application will allow users to add a local folder to add local files for search and playback.
- pp. The VMS Desktop application will have a Video Wall mode which will allow operators to control the application remotely.
- qq. The VMS Desktop application will have a Media Player mode which will allow operators to use the application as a media player.
- rr. The VMS Desktop application will remember past system connections and user credentials and will allow operators to quickly search for and switch between systems.
- ss. The VMS Desktop application will allow operators to adjust the aspect ratio and streaming quality (high resolution or low resolution) of items displayed on the viewing grid.
- tt. The VMS Desktop application will display I/O devices as an individual item on the viewing grid and allow operators to create custom names for inputs and output.
- uu. The VMS Desktop application will allow users to customize the layout of I/O panels on the item in the viewing grid including indicators for inputs and buttons for outputs.
- vv. The VMS Desktop application will allow users to de-warp any fisheye lens using automatic calibration or manual calibration without the need for any third (3rd) party SDKs.
- ww. The VMS Desktop application will allow users to create fully customizable viewing tours which include any combination of live video streams, offline

- videos, images, websites (or URLs), I/O devices, and Server health monitoring status.
- xx. The VMS Desktop application will allow system administrators to modify and save a shared layout to affect an instantaneous change to that layout on the VMS Desktop application of any user connected to the system viewing that layout (when the system administrator saves the layout the layout will update in real time for any user viewing that layout).
- yy. The VMS Desktop application will support two-way audio between operators and supported devices.
- zz. The VMS Desktop application will support audio alerts as an action that can be played on users' computers or connected system devices.
- aaa. The VMS Desktop application will support PTZ presets and tours.
- bbb. The VMS Desktop application will support PTZ presets and tours in fisheye cameras using de-warp mode.
- ccc. The VMS Desktop application will allow operators to schedule recording for connected cameras and devices with options to force minimum and maximum storage durations.
- ddd. The VMS Desktop application will allow operators to configure pre and post recording for motion events.
- eee. The VMS Desktop application will allow operators to optimize camera streaming quality from connected devices automatically using low, medium, high, best quality selectors or manually in the camera.
- fff. The VMS Desktop application will allow users to export video by selecting an area on the timeline and right clicking to export.
- ggg. The VMS Desktop application will support single video export in .avi, .mp4, or .mkv formats and will offer the option to transcode any client-side effects (image enhancement, de-warping, timestamps) as part of the exported video.
- hhh. The VMS Desktop application will support multi-video export in an executable format to create a fully portable version of the VMS Desktop application including all exported video files.
- iii. The VMS Desktop application shall have a rapid review export feature which will allow operators to compress any length of video into a short video (e.g. export 8 hours of archives into a 30 second video clip).
- jjj. The VMS Desktop application shall allow system administrators to activate or deactivate system licenses on Internet connected systems.
- kkk. The VMS Desktop application shall allow users to force open an alarm layout triggered by any system or 3rd party event with one or many associated cameras or resources.
- lll. The VMS Desktop application will have a hidden configurable method of increasing the amount of items allowed on the viewing grid.
- mmm. The VMS Desktop application shall allow users to adjust configuration of devices.
- nnn. The VMS Desktop application shall support keyboard shortcuts to control various interface options including PTZ mode, Smart Search mode, & layout control.
- ooo. VMS will allow analytics from Wisenet and other supported device with analytics (Axis, DW, Hikvision)
- ppp. The VMS Desktop application will force users to set an initial password for Wisenet camera upon enrollment, for best cyber security practices.

F. VMS Mobile Application

1. Supported Operating Systems: Google Android, Apple iOS.
2. Features:
 - a. The VMS Mobile application will automatically discover available Systems on a local area network (LAN).
 - b. The VMS Mobile application will store past system connections and credentials and will allow users to quickly search for switch between systems.
 - c. The VMS Mobile application will have adaptive streaming and automatically adjust the stream being displayed based on network speed.
 - d. The VMS Mobile application will allow users to adjust streaming resolutions manually.
 - e. The VMS Mobile application will allow users to search for cameras by name.
 - f. The VMS Mobile application will allow fisheye de-warping of any fisheye lens without the need for any 3rd party SDK.
 - g. The VMS Mobile application will allow users to view live video from one system.
 - h. The VMS Mobile application will allow users to log in to the VMS Cloud layer in order to view and access all systems shared with a user.
 - i. The VMS Mobile application will allow users to control the display of any connected "Lite Clients" in the system.
 - j. The VMS Mobile application will utilize a custom media player to render and display live thumbnails and video.
 - k. The VMS Mobile application will allow users to search video using a calendar.
 - l. The VMS Mobile application will allow users to search video using a flex timeline.
 - m. The VMS Mobile application will allow "Smart Motion Search" to search archived video by selecting an entire video or specific area.

G. VMS Cloud Application

1. Supported Browsers
 - a. The VMS Cloud application will allow users to log in from any modern web browser (Google Chrome, Mozilla Firefox, Microsoft Edge, Opera, etc.) from any type of device (mobile, pc, etc.)
2. Features:
 - a. The VMS Cloud application will be an optional add-on to the VMS requiring no additional licensing.
 - b. The VMS Cloud application will allow users to connect an unlimited number of systems to a single user account.
 - c. The VMS Cloud application will allow system administrators to share access to a system using only an email address.
 - d. The VMS Cloud application will allow system administrators to assign custom user roles when sharing system access.
 - e. The VMS Cloud application will allow users to quickly search for and connect to cloud-connected systems by name.
 - f. The VMS Cloud application will allow operators to view live or recorded video from one camera at a time on any cloud-connected system.

- g. The VMS Cloud application will first attempt a direct connection to system servers using NAT Traversal technology and will be able to proxy traffic to ensure access to a system in the case of ISP or routing issues.
- h. The VMS Cloud application will allow an unlimited number of connected users and systems with no additional licensing.
- i. The VMS Cloud application will utilize secure networking technologies (OpenSSL, HTTPS) and a complex Salted MD5 hash for any stored passwords.
- j. The VMS Cloud application will allow two systems to be merged together to operate as one system without the need for port forwarding or local access.

H. Basis of Design: Hanwha Wisenet WAVE (or approved equal)

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 271100 "Structured Cabling System."

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.

END OF SECTION 28 20 00

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. Nonsystem smoke detectors.
6. Heat detectors.
7. Notification appliances.
8. Device guards.
9. Firefighters' two-way telephone communication service.
10. Firefighters' smoke-control station.
11. Magnetic door holders.
12. Remote annunciator.
13. Graphic annunciator.
14. Addressable interface device.
15. Digital alarm communicator transmitter.
16. Radio alarm transmitter.
17. Network communications.
18. System printer.

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. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.5 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 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. Smoke Detectors, Heat Detectors, and Flame Detectors: Quantity equal to **TEN PERCENT** of amount of each type installed, but no fewer than one unit of each type.
 2. Detector Bases: Quantity equal to **TWO PERCENT** of amount of each type installed, but no fewer than one unit of each type.
 3. Manual Fire Alarm Box: **ONE** of each type installed.
 4. Keys and Tools: **ONE** extra set for access to locked or tamper-proofed components.
 5. Audible and Visual Notification Appliances: **THREE** of each type installed.
 6. Addressable interface device: **TWO** of each type installed.
 7. Fuses: **TWO** of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
 8. Filters for Air-Sampling Detectors: Quantity equal to **TWO percent** of amount of each type installed, but no fewer than one unit of each type.
 9. Air-Sampling Fan: Quantity equal to **ONE** for every five detectors, but no fewer than one unit of each type.

B. ADDITIONAL INSTALLED DEVICES

1. Electrical Contractor shall include in his bid an allowance for the installation of the following:

a. Smoke detectors	One
b. Duct smoke detectors	One
c. Manual fire alarm box	One
d. Audible device	Two
e. Combination audible/visual device	Five
f. Addressable interface device	One
2. 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 Architect or Engineer. If not all devices are used, the remaining devices shall be turned over to the Owner. The 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 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 - 1. Do not proceed with interruption of fire-alarm service without **A/E's, Construction Manager's, Owner's** written permission.
- C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 SEQUENCING AND SCHEDULING

- A. Prior to beginning work to modify an existing fire alarm system, the contractor shall verify at the control panel that the system has no faults, alarms, or trouble conditions. Verification shall occur in the presence of the Owner or Owner's Rep.
- B. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- C. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.10 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: **FIVE** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. **Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. 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 and **voice, horn/strobe** evacuation.
- 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. Flame detectors.
 - d. Smoke detectors.
 - e. Duct smoke detectors.
 - f. Air-sampling smoke-detection system
 - g. Carbon monoxide detectors.
 - h. Combustible gas detectors.
 - i. Automatic sprinkler system water flow.
 - j. Preaction system.
 - k. Fire-extinguishing system operation.
 - l. Fire standpipe system.
 - m. Dry system pressure flow switch.
 - n. Fire pump running.
- 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. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
 - j. Activate stairwell and elevator-shaft pressurization systems.
 - k. Close smoke dampers in air ducts of designated air-conditioning duct systems.

- l. Activate preaction system.
- m. Recall elevators to primary or alternate recall floors.
- n. Activate elevator power shunt trip.
- o. Activate emergency lighting control.
- p. Activate emergency shutoffs for gas and fuel supplies.
- q. Record events in the system memory.
- r. Record events by the system printer.
- s. 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. High- or low-air-pressure switch of a dry-pipe or pre-action sprinkler system.
 - c. Alert and Action signals of air-sampling detector system.
 - d. Elevator shunt-trip supervision.
 - e. Fire pump running.
 - f. Fire-pump loss of power.
 - g. Fire-pump power phase reversal.
 - h. Independent fire-detection and -suppression systems.
 - i. User disabling of zones or individual devices.
 - j. Loss of communication with any panel on the network.
 - k. Generator running
 - l. Generator abnormal condition (e.g. failure to start, temperature alarms, low fluids, etc.)
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. Record the event on system printer.
 - c. After a time delay of **200 seconds**, transmit a trouble or supervisory signal to the remote alarm receiving station.
 - d. Transmit system status to building management system.
 - e. 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. Record the event on system printer.
 - c. Transmit system status to building management system.
 - d. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event.**"

2.4 FIRE-ALARM CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers:
 - 1. Fire-Lite Alarms.
 - 2. GAMEWELL.
 - 3. GE UTC Fire & Security; A United Technologies Company.
 - 4. Notifier.
 - 5. Siemens Industry, Inc.; Fire Safety Division.
 - 6. Silent Knight.
 - 7. SimplexGrinnell LP.
 - 8. EST Edwards
- 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 and printer.
 - 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 A, **Class B**.
 - 3. Pathway Survivability: Level 0, **Level 1**.
 - 4. Install no more than 50, **100, 256** 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. Stairwell **and Elevator Shaft** Pressurization: Provide an output signal using an addressable relay to start the stairwell **and elevator shaft** pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.

1. Pressurization starts when any alarm is received at fire-alarm control unit.
2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.

F. 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. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

G. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

H. 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.

I. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall **be, not be** connected to fire-alarm system.

J. 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, and print out the final adjusted values on system printer.

- K. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- L. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided **in a separate cabinet located in the fire command center as a special module that is part of fire-alarm control unit.**
 - 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.
- M. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- N. 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 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.
- O. 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, Vented wet-cell pocket plate nickel cadmium.**

P. 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.

Q. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 PREACTION SYSTEM

A. Initiate Presignal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a preaction system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

2.6 REMOTE FIRE ALARM DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers:

1. Cooper Wheelock.
2. Fire-Lite Alarms.
3. GAMEWELL.
4. GE UTC Fire & Security; A United Technologies Company.
5. Notifier.
6. Siemens Industry, Inc.; Fire Safety Division.
7. Silent Knight.
8. SimplexGrinnell LP.
9. System Sensor.

B. 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.**

Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

- d. **Weatherproof Protective Shield:** Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

C. 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. **Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.**
3. **Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.**
4. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
5. 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, **RED WHITE**.
6. 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 semirecessed or surface mounted and bidirectional.
 - f. Matching Transformers: Tap range matched to acoustical environment of speaker location.
 - g. Mounting Faceplate: Factory finished, **RED WHITE**.
7. Exit Marking Audible Notification Appliance:
 - a. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.

- b. Provide exit marking audible notification appliances at the entrance to all building exits.
- c. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

D. 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.

E. 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. Ionization Smoke Detector:
 - 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.).
4. 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.
5. Projected Beam Smoke Detectors
 - a. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.
 - b. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.

- c. 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.).

F. Carbon Monoxide Detectors

- 1. General: Carbon monoxide detector listed for connection to fire-alarm system.
 - a. Mounting: Adapter plate for outlet box mounting.
 - b. Testable by introducing test carbon monoxide into the sensing cell.
 - c. Detector shall provide alarm contacts and trouble contacts.
 - d. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 - e. Comply with UL 2075.
 - f. Locate, mount, and wire according to manufacturer's written instructions.
 - g. Provide means for addressable connection to fire-alarm system.
 - h. Test button simulates an alarm condition.

G. Multicriteria Detectors

- 1. Mounting: Adapter plate for outlet box mounting Twist-lock base interchangeable with smoke-detector bases.
- 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- 3. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.
- 4. Test button tests all sensors in the detector.
- 5. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present sensitivity selected.
 - d. Sensor range (normal, dirty, etc.).
- 6. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.
 - a. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
 - b. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
 - c. Heat sensor shall be as described in "Heat Detectors" Article.
 - d. Each sensor shall be separately listed according to requirements for its detector type.

H. Nonsystem Smoke Detectors

1. General Requirements for Nonsystem Smoke Detectors:
 - a. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
 - b. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.
2. Single-Station Smoke Detectors:
 - a. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
 - b. Auxiliary Relays: One Form C, rated at 0.5 A Form A and one Form C, both rated at 0.5 A.
 - c. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
 - d. Visible Notification Appliance: 177-cd strobe.
 - e. Heat sensor, 135 deg F combination rate-of-rise and fixed temperature.
 - f. Test Switch: Push to test; simulates smoke at rated obscuration.
 - g. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
 - h. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - i. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - j. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
3. Single-Station Duct Smoke Detectors:
 - a. Comply with UL 268A; operating at 120-V ac.
 - b. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - 1) Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot when tested according to UL 268A.
 - c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
 - 1) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.
 - d. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - e. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

I. 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.
- 3. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of **190 deg F** .
 - 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.
- 4. Continuous Linear Heat-Detector System:
 - a. Detector Cable: Rated detection temperature **155 deg F**. Listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short circuit wires at the location of elevated temperature.
 - b. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
 - c. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.
 - d. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

J. Air-Sampling Smoke Detector

- 1. General Description:
 - a. Air-sampling smoke detector shall be laser based using a piping system and a fan to transport the particles of combustion to the detector.
 - b. Provide two levels of alarm from each zone covered by the detector and two supervisory levels of alarm from each detector.
 - c. The air being sampled shall pass through filters to remove dust particulates greater than 20 microns before entering the detection chamber.
 - d. Detectors shall have the capability via RS 485 to connect up to 100 detectors in a network.
 - e. Detectors shall communicate with the fire-alarm control unit via addressable, monitored dry contact closures, RS 485, and interface modules. Provide a minimum of six relays, individually programmable remotely for any function.

- f. Pipe airflow balancing calculations shall be performed using approved calculation software.
2. Detector:
- a. Detector, Filter, Aspirator, and Relays: Housed in a mounting box and arranged in such a way that air is drawn from the detection area and a sample passed through the dual-stage filter and detector by the aspirator.
 - b. Obscuration Sensitivity Range: **0.005 - 6 percent obs/ft.**
 - c. Four independent, field-programmable, smoke-alarm thresholds per sensor pipe and a programmable scan time delay. The threshold set points shall be programmable.
 - 1) The four alarm thresholds may be used as follows:
 - a) Alarm Level 1 (Alert): Activate a visual and an audible supervisory alarm.
 - b) Alarm Level 2 (Action): Activate shutdown of electrical/HVAC equipment and activate a visual and an audible supervisory alarm.
 - c) Alarm Level 3 (Fire 1): Activate building alarm systems and initiate call to fire response unit.
 - d) Alarm Level 4 (Fire 2): Activate suppression system or other countermeasures.
 - 2) Final Detection System Settings: Approved by **Architect Owner**.
 - 3) Initial Detection Alarm Settings:
 - a) Alarm Level 1 (Alert): 0.08 percent obs/ft.
 - b) Alarm Level 2 (Action): 1.0 percent obs/ft.
 - c) Alarm Level 3 (Fire 1): 2.0 percent obs/ft.
 - d) Alarm Level 4 (Fire 2): 4.0 percent obs/ft.
 - d. Power Supply:
 - 1) Regulated 24-V dc, monitored by the fire-alarm control unit, with battery backup.
 - 2) Battery backup shall provide 24 hours' standby, followed by 30 minutes at maximum connected load.
 - e. Detector shall also transmit the following faults:
 - 1) Detector.
 - 2) Airflow.
 - 3) Filter.
 - 4) System.
 - 5) Zone.
 - 6) Network.
 - 7) Power.
 - f. Provide four in-line sample pipe inlets that shall contain a flow sensor for each pipe inlet. The detector shall be capable of identifying the pipe from which smoke was detected.
 - g. Aspirator: Air pump capable of allowing for multiple sampling pipe runs up to 650 feet in total, (four pipe runs per detector) with a transport time of less than 120 seconds from the farthest sample port.
 - h. Air-Sampling Flow Rates Outside Manufacturer's Specified Range: Result in a trouble alarm.

- i. Provide software-programmable relays rated at 2 A at 30-V dc for alarm and fault conditions.
 - j. Provide built-in event and smoke logging; store smoke levels, alarm conditions, operator actions, and faults with date and time of each event. Each detector (zone) shall be capable of storing up to 18,000 events.
 - k. Urgent and Minor Faults. Minor faults shall be designated as trouble alarms. Urgent faults, which indicate the unit may not be able to detect smoke, shall be designated as supervisory alarms.
- 3. Displays:
 - a. Include display module within each detector.
 - b. Each display shall provide the following features at a minimum:
 - 1) A bar-graph display.
 - 2) Four independent, high-intensity alarm indicators (Alert, Action, Fire 1, and Fire 2), corresponding to the four alarm thresholds of the indicated sector.
 - 3) Alarm threshold indicators for Alert, Action, and Fire 1.
 - 4) LED indication that the first alarm sector is established.
 - 5) Detector fault and airflow fault indicators.
 - 6) LED indicators shall be provided for faults originating in the particular zone (Zone Fault), faults produced by the overall smoke-detection system, and faults resulting from network wiring errors (Network Fault).
 - 7) Minor and urgent LED fault indicators.
- 4. Sampling Tubes:
 - a. Smooth bore with a nominal 1-inchOD and a 7/8-inchID. Sampling pipe with between 5/8- and 1-inchID can be used in specifically approved locations when recommended by manufacturer.
 - b. Pipe Material: CPVC and complying with UL 1887, "Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics."
 - c. Joints in the sampling pipe shall be airtight. Use solvent cement approved by the pipe manufacturer on all joints except at entry to the detector.
 - d. Identify piping with labels reading: "Aspirating Smoke Detector Pipe - Do Not Paint or Disturb" along its entire length at regular intervals according to NFPA 72.
 - e. Support pipes at not more than 60-inchcenters.
 - f. Fit end of each trunk or branch pipe with an end cap and drilled with a hole appropriately sized to achieve the performance as specified and as calculated by the system design.
- 5. Sampling Holes:
 - a. Sampling holes of 5/64 inch, or other sized holes per manufacturer's written instructions, shall be separated by not more than the maximum distance allowable for conventional smoke detectors. Intervals may vary according to calculations.
 - b. Follow manufacturer's written recommendations to determine the number and spacing of sampling points and the distance from sampling points to ceiling or roof structure and to forced ventilation systems.
 - c. Each sampling point shall be identified by an applied decal.

K. 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.

L. Graphic Annunciator

1. Graphic Annunciator Panel: Mounted in an aluminum frame with nonglare, minimum 3/16-inch-thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.
 - a. Comply with UL 864.
 - b. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.
 - c. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
 - d. **Surface** mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
 - e. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at **1/8-inch per foot** scale or larger.
 - f. The LED representing a detector shall flash **two** times per second while detector is an alarm.
2. 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.

M. 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 Surface** 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.

2.7 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

- A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, **the fire command center**, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:
1. Common-talk type for firefighter use only Selective-talk type for use by firefighters and fire wardens.
 2. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.
 3. Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Module shall be capable of differentiating between normal, off-hook, and trouble conditions.
 4. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it causes an audible signal to sound and a high-intensity lamp to flash at the **fire-alarm control unit fire command center**.
 5. Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
 6. Display: **Graphic digital** to indicate location of caller.
 7. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.
 - a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating **"Fire Warden Phone" or "Fire Emergency Phone."**
 - b. With "break-glass" type door access lock.
 8. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved **"Fire Warden Phone" or "Fire Emergency Phone."**
 9. Handsets: push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control unit in the fire command center.

2.8 FIREFIGHTERS' SMOKE-CONTROL SYSTEM

- A. Initiate Smoke-Management Sequence of Operation:
1. Comply with sequence of operation as described in Section 230993 "Sequence of Operations for HVAC Controls."
 2. Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.
 3. First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.
 4. Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.
- B. Addressable Relay Modules:

1. Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.
2. Allow the control panel to switch the relay contacts on command.
3. Have a minimum of two normally open and two normally closed contacts available for field wiring.
4. Listed for controlling HVAC fan motor controllers.

2.9 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture **one two** telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. 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.
- D. Digital data transmission shall include the following:
 1. Address of the alarm-initiating device.
 2. Address of the supervisory signal.
 3. Address of the trouble-initiating device.
 4. Loss of ac supply.
 5. Loss of power.
 6. Low battery.
 7. Abnormal test signal.
 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.10 RADIO ALARM TRANSMITTER

- A. Transmitter shall comply with NFPA 1221 and 47 CFR 90.
- B. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.
 - 1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 - 2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
 - 3. Normal Power Input: 120-V ac.
 - 4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 - 5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand **100 mph** with a gust factor of 1.3 without failure.
 - 6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 - 7. Antenna-Cable Connectors: Weatherproof.
 - 8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
- C. Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
 - 1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 - 2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
 - 3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
 - 4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
 - 5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
 - 6. Local Fire-Alarm-System, Supervisory-Alarm Message: **Actuated when the building alarm system indicates a supervisory alarm .**

2.11 NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.
- C. Provide integration gateway using **BACnet Modbus** for connection to building automation system.

2.12 SYSTEM PRINTER

- A. Printer shall be listed and labeled as an integral part of fire-alarm system.

2.13 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.

2.14 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. Network Riser Cable: Utilize MI type cable, 2-hour fire resistive rating. Applies to all wiring between fire alarm control panels (FACP) and between control panels and notification appliance cabinets (NAC).
- C. 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.
- D. 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.
- E. **600V THHN shall be suitable for use with SLC and NAC circuits, #18 AWG and #14 AWG, respectively.**
- F. All wiring shall be color coded and labeled at each end. Splicing by way of wire nuts is prohibited.
- G. All fire alarm wiring shall be plenum rated where located in air plenum.

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. Connecting to Existing Equipment: Verify that existing fire-alarm 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.
 - 3. Expand, modify, and supplement existing **control monitoring** equipment as necessary to extend existing **control monitoring** functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Equipment Mounting: Install fire-alarm control unit on finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. 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.
- F. 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.
- G. 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.
- H. 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.
- I. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.
- J. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- K. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- L. 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.
- M. 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.

- N. 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.
- O. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- P. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists **100-mph** wind load with a gust factor of 1.3 without damage.

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. Fire alarm cable shall be installed in raceway.**
- C. Where approved for use, THHN shall be installed in raceway.**
- D. Exposed fire alarm raceways shall be painted red enamel.

3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. 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. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
 - 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
 - 3. Smoke dampers in air ducts of designated HVAC duct systems.
 - 4. Magnetically held-open doors.
 - 5. Electronically locked doors and access gates.
 - 6. Alarm-initiating connection to elevator recall system and components.
 - 7. Alarm-initiating connection to activate emergency lighting control.
 - 8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 9. Supervisory connections at valve supervisory switches.

10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

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 **Architect authorities having jurisdiction**.
- 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, replacement repair or 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, Train** Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11

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SECTION 28 50 00

EMERGENCY RESPONDER RADIO SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the criteria for an Emergency Responder Radio System (ERRS). An ERRS must be provided within the building if the initial Radio Signal Strength and Clarity Study fails to achieve minimum signal strength in 95% of all areas on each floor of the building.
 - 1. Base Bid includes all work and documentation required for the initial Radio Signal Strength and Clarity Study.
 - 2. An allowance has been allocated in the event that an ERRS is required. Provide a complete turn-key solution from a single vendor, in accordance with this section.
- B. This section describes the technical and performance criteria for an ERRS to provide complete coverage in the building for the public safety agencies as required by Code, ordinance, and the Authority Having Jurisdiction.
 - 1. The ERRS must not support any other systems outside of the PSN as designated by the AHJ. (The ERRS must not be combined with any other radio systems such as: cellular telephone signal enhancement; wi-fi systems; pager systems; etc.)
 - 2. The ERRS must be expandable to permit future additions and changes to the emergency responder radio frequencies. Note, at the present time, the emergency responder radio frequencies operate in the 800MHz band. A change to the 700MHz band may be deployed in the future and the building Owner will be required to modify the ERRS accordingly. Prior approval of an 800MHz system does not exempt this requirement.
 - 3. The ERRS shall permit the simultaneous use and interoperability of analog and digital modulation radios.
 - 4. The ERRS shall be neutral host and nonproprietary.
 - 5. Maximum power output: The maximum power allowed by FCC. The minimum power required to carry out the desired communication shall not be exceeded. It is the responsibility of the professional installer to stay within the power limits.
- C. Final acceptance and approval for the initial Radio Signal Strength and Clarity Study shall be at the sole discretion of the local Fire Department and AHJ.

- D. Final acceptance and approval for the documentation and installation of an ERRS shall be at the sole discretion of the local Fire Department and AHJ.

1.2 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction.
- B. BDA: Bi-Directional Amplifier.
- C. DAQ: Delivered Audio Quality
 - 1. DAQ 1: Unusable, speech present but not understandable.
 - 2. DAQ 2: Speech present but not understandable without considerable effort.
 - 3. DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise or distortion.
 - 4. DAQ 3.5: Speech understandable with repetition only rarely required, with some noise or distortion.
 - 5. DAQ 4: Speech easily understood with occasional noise or distortion.
 - 6. DAQ 4.5: Speech easily understood with infrequent noise or distortion.
 - 7. DAQ 5: Speech easily understood.
- D. FCC: Federal Communications Commission.
- E. NFPA: National Fire Protection Association.
- F. OBC: Ohio Building Code.
- G. OFC: Ohio Fire Code.
- H. PSN: Public Safety Network.
- I. UL: Underwriters Laboratory.

1.3 SUBMITTALS

- A. Qualification Data: For Installer.
- B. Radio Signal Strength and Clarity Study.
- C. Submit product data for each type of proposed system component specified, including dimensioned drawings showing minimum clearances and installed features.
- D. ERRS Plans: Refer to the Fire Department's latest published ERRS Guidelines for specific requirements for plans and attachments. Failure to provide any of the

information required by the Fire Department or AHJ will result in the plans and attachments being disapproved.

1. Plans and attachments shall be clearly labeled and legible.
 2. Plans and all revisions to the plans shall be dated. If utilizing an existing drawing or portion of a drawing, the area of work shall be highlighted and clouded with an appropriate symbol. Provide a revision list with a symbol, date, description, and initials.
 3. Plans shall include a title sheet, an equipment list, a floor plan, a system riser diagram, and secondary power calculations.
 4. Attachments shall include the manufacturer's specification sheets for all equipment and devices such as; cables, amplifiers, UPS, batteries, and antenna; indicating the FCC certification.
- E. Operation and Maintenance Manuals: Maintenance data for the ERRS shall be included in the operation and maintenance manual.
1. Include data for each type of product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.
 2. Record of field tests of the radio system shall be included in the operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: The installer must have a valid FCC-issued radio operator license. The installer must have certification of in-building system training by a nationally recognized organization or school or have a certificate issued by the equipment manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Compatibility: The equipment, including but not limited to repeaters, transmitters, receivers, signal boosters, cabling, fiber distributed antenna system, etc., shall not interfere with the existing communication systems utilized by the Public Safety and First Responder agencies.
- B. Power Supplies: The ERRS shall be provided with (2) independent and reliable power sources, one primary and one secondary. When primary power is lost, the power supply to the ERRS shall automatically transfer to the secondary power supply

1. The primary power source shall be supplied from a dedicated 20 amp, 120 volt branch circuit and comply with NFPA 72.
2. The secondary power source shall be an approved secondary source of power per Ohio Fire Code.
 - a. The design capacity of the secondary source shall be 24 hours of Standby plus 24 hours of 100% of system operation (means of two-way communication).
 - b. The secondary power source shall be contained in one or more type NEMA 4 or NEMA 4X enclosures.
3. Provide supervisory and trouble signals indicating impairment of each power source. Connect the supervisory and trouble alarm contacts to the building fire alarm system.

C. Survivability:

1. Physical Protection: All wiring and fiber optics shall be installed in conduit. Refer to Section 26 05 33, "Raceways and Boxes for Electrical Systems" for type, sizing, and installation standards.
2. Fire Performance: All main risers or trunks of the antenna system shall be installed with resistance to attack from a fire using one of the following methods:
 - a. A 2-hour fire rated cable or cable system.
 - b. Routing the cable through a 2-hour fire rated enclosure(s) or shaft(s).
 - c. A system configured in a looped design, routed through 1-hour fire rated enclosure(s) or shaft(s). The circuit shall be capable of transmitting and receiving a signal during a single open or non-simultaneous single ground fault on a circuit conductor.
 - d. Performance alternative approved by the authority having jurisdiction.
3. Cabinet: The signal booster and all associated RF filters shall be housed in a single, NEMA 4 certified, painted steel weather tight box. The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere. Operating temperatures: -22 degrees F to +120 degrees F (-30 degrees C to +50 degrees C) minimum temperature range, including microprocessors. Equipment installed on the roof of structures shall be rated for the expected extreme temperatures associated with rooftop installations.
4. Passive Equipment: Passband shall be 700-900 MHz, IP rating of 2 GHz.
5. Cable: Passband shall be 700-900 MHz. Cable shall be rated for fire plenum and riser rating.

2.2 SYSTEM DESCRIPTION

A. Permissible Systems

1. Buildings and structures shall be equipped with an FCC Certificated Class B Bi-Directional UHF Amplifier(s) as needed.
2. The distributed antenna system may utilize a radiating cable, fixed antennas or a combination of both.

B. Signal Strength

1. Downlink: A minimum signal strength of -95 dBm shall be provided throughout the coverage area.
2. Uplink: Minimum signal strength of -95 dBm received at the local Fire Department Radio System from the coverage area.
3. A donor antenna must maintain isolation from the distributed antenna system. The donor antenna signal level shall be a minimum of 20 dB above the distributed antenna system under all operating conditions.

C. All 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. RF Coaxial Cable shall be a listed, CMP plenum. Non-plenum cable can be used when installed in a metallic raceway. The cable classification shall be clearly marked on the outer surface of the cable regular intervals.

E. Reject Filters: Notch filter sections shall be incorporated to minimize adjacent channel cellular and SMR (Nextel) degradation of the signal booster performance. The minimum downlink band adjacent band rejection shall be 35 dB or greater at 865 MHz and 870 MHz.

F. Band Migration Capability: The signal booster shall include re-tunable or replaceable filters to accommodate rapid and economic passband changes in the event of mandatory FCC changes within the NPSPAC band. The use of non-adjustable and non-replaceable RF input and output filters is prohibited.

G. Output Level Control: An automatic output leveling circuit shall be included for both passbands with a minimum dynamic range of 60 dB, less any gain reduction setting, to maintain FCC out of band and spurious emission compliance.

H. Degraded Performance in Emergencies: The system shall be designed to allow degraded performance in adverse conditions, such as abnormally high temperatures resulting from nearby fires, extreme voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. under/over voltage, over/under current, over/under temperature, etc.) will not be implemented as the standard mode for public safety applications.

- I. Mode of Operation: The system shall be normally powered on and shall continuously provide passing of frequencies within the Public Safety and First Responder bands.

2.3 SYSTEM MONITORING

- A. The distributed antenna system shall include connections to the fire alarm system to monitor the integrity of the circuit of the signal booster(s) and power supplies and annunciate this malfunction on the fire alarm system shall comply with 4.4.7.1 of NFPA 72. As a Minimum, the following conditions shall be monitored through the fire alarm system:
 - 1. Antenna Malfunction
 - 2. Signal Booster Failure
 - 3. Low Battery Capacity, sending a supervisory signal at 70% of battery capacity.
 - 4. Loss of normal AC power.
 - 5. Failure of battery charger.
- B. Program the fire alarm system to relay ERRS supervisory and trouble signals to the appropriate supervising station. Instruct supervising station personnel to notify the Fire Department of the impairment.

2.4 SIGNAGE

- A. Signage shall be provided in accordance with the following: A sign shall be located seven feet above grade directly above or near the building Knox Key Box stating "ERRS" with Radio Logo. If the building does not have a Knox Key Box the sign shall be located within five feet of the main entrance at the same height stated above. A sign shall also be provided at the fire alarm annunciator panel.

PART 3 - EXECUTION

3.1 PERMITS & LICENSING

- A. ERRS Construction Permit: The permit applicant shall be the installing contractor. The contractor shall submit associated fees to the Owner for reimbursement.
 - 1. If outdoor antennas are required, obtain approval of Building and Zoning Services for all antenna locations.
- B. Operating Permit: The ERRS will require a yearly operating permit. The Owner shall contact the Bureau of Fire Prevention as soon as possible after the project final, to obtain the yearly operating permit. The Owner shall be responsible for all associated fees.

- C. The ERRS equipment shall have FCC certification prior to installation.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 1221, OFC, and requirements of the AHJ for installation and testing of emergency radio communications equipment. Install all electrical wiring to comply with requirements in NFPA 70.
- B. The ERRS installation and components shall also comply with all applicable federal regulations including, but not limited to, FCC 47 CFR Part 90.219.
- C. Distribution System Signal Wires and Cables
 - 1. Wires and cables shall enter each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.
 - 2. Wires or cables routed between consoles, cabinets, racks, and other equipment shall be installed in an approved conduit or cable tray that is secured to building structure.
 - 3. Install cables without damaging conductors, shield, or jacket.
 - 4. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
 - 5. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 6. Test all cables after installation and replace any that are found to be defective.
- D. System Installation
 - 1. Coaxial antenna cabling shall not be installed in the same conduit, raceway, or cable trays used for other systems.
 - 2. All equipment shall be connected according to the OEM's specifications to ensure correct installation and system performance.
 - 3. Coordinate all roof penetrations with Owner and/or roofing contractor.

3.3 GROUNDING

- A. Ground cable shields and equipment per the manufacturer's requirements.
- B. Antenna mast shall be grounded per NFPA 70 and antenna manufacturer's requirements. Provide grounding blocks and surge protection for outside coaxial cabling.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 RADIO SIGNAL STRENGTH AND CLARITY STUDY

- A. When the building is "closed in" perform the initial Radio Signal Strength and Clarity Study.
- B. The study shall be performed in compliance with OFC 510, the local Fire Department and AHJ requirements.
 - 1. Follow the acceptance testing procedures included in this specification, except that the initial study shall be run on a 20 grid block per floor.
 - 2. If more than one block on a given floor is over the -95 dBm threshold, has a DAQ less than 3.0, or if a critical area has poor coverage, then an ERRS will likely be required.
 - 3. If the building passes the initial Radio Signal Strength and Clarity Study, submit the results to the Fire Department for review and approval. Schedule a final inspection with the Fire Department.

3.6 FIELD QUALITY CONTROL

- A. Provide acceptance testing for the Emergency Responder Radio System upon completion of installation.
- B. Provide coverage testing in accordance with NFPA 72, NFPA 1221, OFC, and as required by the AHJ.
- C. All tests must be conducted, documented, and signed by a person in possession of a current FCC General Radio Operator License.
- D. Tests shall be conducted using a calibrated portable radio of the latest brand and model used by the agency talking through the agency's radio communication system.
- E. Utilize a spectrum analyzer or other suitable test equipment to ensure spurious oscillations are not being generated by the signal booster.
- F. All measurements shall be made with the antenna held in a vertical position at 3 to 4 feet above the floor to simulate a typical portable radio worn on the belt or turnout coat pocket.
- G. Submit test records per the local Fire Department and AHJ requirements. Include the following:
 - 1. The testing method used; readings taken, and final results.

2. Small scale drawings of each floor of the structure. The plans shall show each floor divided into the grids as described above and all critical areas. Each grid and critical area shall be labeled to indicate the dBm level and DAQ result from the test.

3.7 MAINTENANCE AND ANNUAL TESTING

- A. Annual tests will be conducted by the local Fire Department unit or authorized company.

1. The re-testing will be done at no expense to the City or the appropriate emergency services departments as required in the original testing procedures.

- B. Maintenance Contract

1. Maintenance contract with a Radio Service Provider in place with name of authorized company, who will provide a 24 hour by 7 day emergency response within two (2) hours after notification. The system shall be maintained in accordance with FCC requirements. The contract shall be for 5 years.
2. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio Operator License or equivalent as determined by the local Fire Department.
3. Maintain a list of contact personnel with phone numbers at the radio repeater system cabinet. The contact personnel shall have knowledge of the building and the repeater system and be available to respond to the building in the case of an emergency.
4. Annual Testing shall include, but is not necessarily limited to:
 - a. All active components of the distributed antenna system, including but not limited to amplifier, power supplies, and back-up batteries, shall be tested a minimum of once every 12 months.
 - b. Amplifiers shall be tested to insure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
 - c. Back-up batteries and power supplies shall be tested under load for a period of 1 hour to verify that they will operate during an actual power outage.
 - d. Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
 - e. Documentation of the annual test shall be maintained on site and a copy forwarded to the local Fire Department upon completion of the test.

5. Agency personnel shall have the right to enter onto the property at any reasonable time to conduct field testing to be certain that the required level of radio coverage is present.

END OF SECTION 28 50 00

SECTION 31 00 00

EARTHWORK

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Remove topsoil and stockpile for later reuse.
- B. Excavate subsoil and stockpile for later reuse.
- C. Grade and contour site to elevations indicated on Drawings.
- D. Remove from site excess topsoil and subsoil.
- E. Fill under slabs on grade, foundations, sidewalks, and paving.
- F. Compaction.
- G. Excavation.
- H. Fill for over-excavation.
- I. Finish grade subsoil.
- J. Place, level, and compact topsoil.
- K. Building perimeter backfilling.

1.02 RELATED WORK

- A. Section 01 40 00, "Quality Requirements"
- B. Section 03 30 00, "Cast-in-Place Concrete"
- C. Section 31 10 00, "Site Clearing"
- D. Section 31 23 33, "Piped Utilities - Basic Methods"
- E. Section 31 25 00, "Erosion and Sediment Control"
- F. Section 32 12 00, "Flexible Pavement"
- G. Section 32 13 00, "Rigid Pavement"
- H. Section 33 11 00, "Water Distribution"
- I. Section 33 30 00, "Sanitary Sewerage"
- J. Section 33 40 00, "Storm Drainage"
- K. Section 33 51 00, "Natural Gas Distribution"

L. Section 32 92 00, "Turf and Grasses"

1.03 PROJECT RECORD DOCUMENTS

A. Accurately record location of existing utilities remaining, rerouted utilities, new utilities by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM) C136- Method for Sieve Analysis for Fine and Coarse Aggregates.

B. ASTM D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, using 5.5 lb. (2.49 kg) Rammer and 12 inch (304.8 mm) Drop.

C. ASTM D422 – Particle Size Analysis of Soils.

D. ASTM D4318 – Liquid Limit, Plastic Limit, and Plastic Index of Soils.

E. ASTM D2487 – Classification of Soils for Engineering Purposes (Unified Soil Classification System).

F. ASTM D2488 – Description and Identification of Soils (Visual – Manual Procedure).

G. ASTM D1556 – Test Method for Density of Soil in Place by the Sand-Cone Method.

H. ASTM D2922 – Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

I. ASTM D3017 – Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

J. Ohio Department of Transportation (ODOT); Construction and Materials Specifications.

1.05 PROTECTION

A. Protect trees, shrubs, lawns, and other features remaining as portion of final landscaping.

B. Protect benchmarks, existing structures, roads, sidewalks, and paving and curbs.

C. Protect above or below grade utilities which are to remain.

D. Repair damage.

E. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.

F. Protect bottom of excavations and soil adjacent to and beneath foundation, from freezing.

1.06 DEFINITIONS - The following govern earthwork materials, conditions, and operations.

- A. Stripping: Removal of existing surficial unsuitable materials (see definition) to their entire depth or as indicated.
- B. Excavation: Cutting, digging, removing, and wasting materials of every description, including soils, foundations, rock and whatever substance encountered to dimensions, limits, elevations and contours as indicated or required by either the Drawings or these Specifications.
- C. Rock: Boulders and detached stones having a volume of 2/3 cubic yard or more and any large masses of igneous, metamorphic, or sedimentary rocks, including firmly conglomerated deposits that cannot be removed with a 1 cubic yard capacity power shovel without drilling or blasting.
- D. Unsuitable Materials: Topsoil, loam, gumbo, mud, muck, silt, expansive clay, peat, soils with an organic content greater than 3% by weight, rubbish, debris, foundation and slab materials, paving materials, rock greater than 6 inches in diameter, soils with a maximum dry weight of less than 100 lbs. per cubic foot, vegetation and frozen or dry lumps. Expansive clay is any clay with a liquid limit in excess of 50 and/or Plasticity Index of 30 or greater.
- E. Unstable Materials: Materials which are not classified as unsuitable materials, but due to their condition of being wet, dry, or frozen, are unacceptable for use in fills.
- F. Imported Fill Material or Borrow: Approved soil materials from sources other than those made available by required excavation of Project. Unless specifically provided, no imported fill shall be obtained within limits of the Project site. Imported fill shall be free of unsuitable or unstable materials and shall be approved by the Testing Agency.
- G. Filling/Backfilling: Placing of approved soil materials in accordance with specified procedures and materials and in conformity with lines, grades, contours, cross-sections, and elevations shown on Drawings or required by these Specifications.
- H. Subgrade: Undisturbed soil or compacted fill material upon which additional fill, sub-base or base course, footing, foundation, or slab cushion is placed.
- I. Engineered Fill: An acceptable soil, aggregate, or man-made material that is placed in a controlled manner to satisfy a defined compaction Specification. The defined compaction Specification would include a maximum lift thickness, an acceptable moisture content range, and a minimum required compaction percentage based on a moisture/density relationship (proctor or relative density).

1.07 QUALIFICATION TESTS

- A. Unless otherwise specified, Contractor shall arrange, supervise, and pay for a Testing Agency to perform the following required qualification tests.
 - 1. Qualification tests on each different fill material (both on-site and imported).
 - 2. Fill Materials: Provide the following information and qualifications tests for each fill material, including select on-site materials, prior to use on project site.
 - a. Location of sources for each required imported materials prior to delivery to site.
 - b. Analysis of fine and coarse aggregate ASTM C-136.

- c. Particle size analysis of soils ASTM D422.
- d. Liquid Limit, Plastic Limit and Plasticity Index, ASTM D4318 – cohesive materials only.
- e. Proctor density or relative density information according to test method identified in the Compaction Requirements Schedule at the end of this Section.

B. Fill material shall not be used until qualification tests have been completed and the Testing Agency has approved the fill material.

1.08 SUBMITTALS

- A. Comply with requirements of General and Special Conditions. Unless noted otherwise, submit two (2) copies of the following items:
- 1. Submit material qualification tests for each fill material used and field density test reports directly from Testing Agency.
 - 2. Submit Testing Agency Certificate of Inspection and Compliance with Specifications for the following:
 - a. Bearing capacity for all footing/foundation subgrades.
 - b. Acceptability of both on-site and borrow fill materials, prior to use.
 - c. Acceptability of subgrade prior to fill placement.
 - d. Acceptability of fill placement.

1.09 SAMPLES

- A. Submit samples under provisions of General and Special Conditions.
- B. Submit 10 lb. sample of each type of fill to Testing Agency in airtight containers.
- C. Samples shall be submitted to the Testing Agency one (1) week prior to fill placement, in order to perform qualification tests.

1.10 LAYOUT

- A. Employ a Professional Surveyor, registered in State of Ohio, to lay out and establish all lines and grades, including centerline of all structural columns.
- B. Erect control points prior to excavation. Protect existing control points.
- C. All surveying costs to be paid by General Trades Contractor.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Type A - ODOT Item 411 - Stabilized Crushed Aggregate.
- B. Type B – Pea Gravel: Natural stone; washed, free of clay, shale, organic matter; graded in accordance with ANSI/ASTM C136, to the following:
- 1. Minimum Size: 1/4 inch.
 - 2. Maximum Size: 5/8 inch.

- C. Type C – Sand: Natural River or bank sand, washed: free of silt, clay, loam, friable or soluble materials, or organic matter graded in accordance with ANSI/ASTM C136, within the following limits.

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4	100
No. 14	10 to 100
No. 50	5 to 90
No. 100	4 to 30
No. 200	0

- D. Type D - Subsoil–Reused, select onsite or borrow soil materials conforming to the following:
1. ASTM D2487 Soil Classification Groups GW, GC, GM, SW, SC, SM, CL, and ML.
 2. Less than 3% organic material by weight.
 3. Free of unstable or unsuitable material or construction debris.

- E. Type E - Coarse aggregate, washed gravel, carbonate stone, graded within the following limits.

<u>Sieve Size</u>	<u>Percent Passing</u>
1 1/2 inches	100
1 inch	95 to 100
1/2 inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5

ODOT ITEM 703 #57.

- F. Type F - Topsoil: Fertile, friable, fine sandy clay loam, uniform in composition, capable of sustaining vigorous plant growth and free of subsoil, stones, lumps, clods, of hard earth, plants, plant roots, sticks, noxious weeds, slag, cinders, demolition debris or other extraneous matter over 1 inch in the largest dimension.
- G. Type G - Concrete: Structural concrete conforming to Section 03 30 00, "Cast-in-Place Concrete" with a compressive strength of 3000 psi.
- H. Type H - Drainage Fill: ODOT Item 703, #8.
- I. Type J - Aggregate Base: ODOT Item 304 - The aggregate shall be crushed carbonate stone or crushed gravel, graded in accordance with ANSI/ASTM C136 within the following limits:

<u>Sieve Size</u>	<u>Total Percent Passing</u>
2 inch	100
1 inch	70 to 100
3/4 inch	50 to 90
No. 4	30 to 60
No. 30	9 to 33
No. 200	0 to 13

Prior to placing, aggregate shall have reasonably uniform moisture content at or near optimum for compaction.

- J. Type K – Bank Run Gravel: The material shall consist of bank run sand and gravel, free of frozen materials, wood, and rubbish. It shall have no more than 20% passing the No. 200 sieve and no particle size larger than 3 inches. Sources of borrow shall be designated well in advance of construction and bulk samples procured and tested in a laboratory to determine compaction characteristics so that this data will be available for the control of fill when construction commences.
- K. Type L - Nonstabilized Drainage Base: Aggregate shall be crushed carbonate stone or gravel from approved sources graded in accordance with ASTM C136 within the following limits:

<u>SIEVE SIZE</u>	<u>PERCENT PASSING</u>		
	<u>Type "NJ"</u>	<u>Type "IA"</u>	<u>Type "CE"</u>
1 1/2 inch	100	-	100
1 inch	95 to 100	100	90 to 100
3/4 inch	-	-	55 to 90
1/2 inch	60 to 80	50 to 80	40 to 75
3/8 inch	-	-	30 to 65
No. 4	40 to 55	-	15 to 40
No. 8	5 to 25	10 to 35	5 to 25
No. 16	0 to 8	-	0 to 12
No. 50	0 to 5	0 to 15	0 to 6
No. 200	-	0 to 6	-

2.02 CONSTRUCTION FENCE

- A. Plastic construction fence, orange in color, with the following properties:

Material - Co-polymer

Typical Aperture Size - 1.3 inches x 1.3 inches

Minimum Tensile Strength:

MD 850 lbs./ft. width

TD 1050 lbs./ft. width

MD 4850 psi

TD 5810 psi

Junction Strength - 90% of rib strength (minimum)

Nominal Porosity - 75%

Ultraviolet Resistance - Fully stabilized

Temperature Range - -22 degrees F to 150 degrees F

Tensar Safety Grid or equal

PART 3 EXECUTION

3.01 GENERAL

- A. The following Specification shall be considered as general criteria for earthwork operations. In those instances where field conditions arise which are not adequately covered by these criteria, instructions for that specific condition will be issued by the Architect/Engineer.
- B. Dust Control:
 - 1. Use all means necessary to control dust on and near the work and on and near all off-site borrow areas if such dust is caused by the Contractor's operations during performance of the work or if resulting from the condition in which the Contractor leaves the site.
 - 2. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site.
- C. Grading operations shall be performed in such a manner as to direct and control storm water runoff so that no damage or erosion occurs. Saturation of cut and fill areas shall be prevented by directing storm water runoff and not allowing ponding to occur. Fills are to be crowned as required to maintain drainage at the end of each workday. Existing drainage routes shall not be choked or obstructed until new ones are available. Temporary culverts, pumps or other equipment shall be used to facilitate drainage of fills during construction, failure to drain storm water shall not be grounds for delay of this contract due to saturated site conditions. The Contractor shall remove and dispose of saturated materials in excess of allowable moisture content at compaction and shall maintain the project schedule at all times.
- D. Dewatering: All excavation, construction, and backfill of pipes or other facilities to be constructed under this Contract shall be constructed under dry conditions. The Contractor shall constantly maintain all excavations in a dewatered, workable condition, and shall be responsible for installing, operating, maintaining, and removing such dewatering systems as are required. The evaluation of the sufficiency of the condition shall be made by the Associate/Engineer and his/her decision shall be binding upon the Contractor. If the Associate/Engineer determines that dewatering is inadequate, the Contractor shall modify his/her methods until such time as the Associate/Engineer then agrees with the adequacy of the operating condition.
- E. Site Grading:
 - 1. Existing Conditions: Visit site and verify earthwork requirements prior to commencing work.
 - a. Existing Grades: Existing grades and contours are indicated on Drawings and represent the best information available on actual existing site conditions. Verify existing grades prior to commencing work. Commencement of work is construed as acceptance of grades and/or contours as correct.
 - b. Subsurface Conditions: Results of explorations are for use in estimating work quantities and design parameters, and for the information of the Bidders only, and neither the Owner nor the Associate/Engineer will be responsible for variations in subsoil deposition and quality or for changes which may have occurred after the investigations were made.
 - c. See logs of explorations for indication of existing soil and rock boundaries.
 - 2. Required contours and elevations are indicated and noted on the Drawings. Should indicated figures conflict with actual conditions and contours, notify the Associate Engineer and await his/her directions before proceeding.

3.02 PROTECTION OF PERSONS AND PROPERTY

- A. Barricade open excavations occurring and post with warning lights from dusk to dawn each day and as otherwise required.
- B. Erect construction barriers to prevent public access to the area of the Work. Maintain in place throughout the new construction operations. Erection, maintenance, alterations, and removal of the barriers shall be the responsibility of the Contractor.
- C. Do not close or obstruct streets or sidewalks without the proper permit. Conduct operations with minimum traffic interference.
- D. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
- E. Protect public and private property adjacent to and on the job site, including vents, utility lines, roadways, sidewalks, light standards, hydrants, and trees not indicated for removal. Repair damage to the property at no cost to the Owner.
- F. Notify local authorities having jurisdiction of existing damage in adjacent streets or improvements such as paving, curbs, gutters, sidewalks, and alley surfacing, prior to start of demolition work. If damage to streets and improvements is discovered after work has commenced, and such damage was not reported before start of work, the Contractor will perform and pay for the necessary repairs.
- G. Maintain and preserve utilities transversing premises as long as they are required. Backfill and compact all excavation made for removal of utilities.
- H. Seal or cap all utility lines leading from demolished structures in accordance with regulations of authorities having jurisdiction.
- I. Before starting work related to existing utilities such as electrical, sewer, water, heat, gas and fire lines that will temporarily discontinue or disrupt service to any existing building, notify the utility companies 72 hours in advance and obtain approval in writing before proceeding with this phase of work.
- J. Earthwork:
 - 1. Stability of temporary excavations:
 - a. All excavations shall be in accordance with OSHA requirements.
 - b. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
 - c. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
 - 2. Shoring:
 - a. Except as specified elsewhere, provide all shoring required for earthwork or required as a result of earthwork for safety of workers, existing structures, public or adjacent properties.
 - b. Provide materials for shoring and bracing in good serviceable condition.
 - c. Establish requirements for shoring and bracing to comply with local codes and authorities having jurisdiction.

- d. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

K. The Engineer has designed a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed, shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.

3.03 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Identify known below grade utilities. Stake and flag locations.
- C. Identify and flag above grade utilities.
- D. Maintain and protect existing utilities remaining which pass-through work area.
- E. Notify utility company to remove and relocate utilities.
- F. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Associate/Engineer.

3.04 ROUGH GRADING AND EMBANKMENT CONSTRUCTION

- A. Rough Grading:
 - 1. Site clearing and grubbing shall be done prior to any rough grading. All debris and deleterious material shall be removed from areas to be filled or backfilled.
 - 2. Dispose of excess excavated material or supply additional suitable material as necessary to complete the rough grading to the required elevations.
 - 3. The finished subgrade surface shall be reasonably smooth and free from irregular surface changes and shall be no more than one tenth (0.1) of a foot above or below the approved subgrade elevation.
 - 4. Newly graded areas shall be protected from the action of the elements. Any damage that may occur as a result of natural causes or any construction activities, prior to the acceptance of the work, shall be repaired and grades re-established to the required elevations and slopes.
 - 5. During the performance of rough grading operations, the subgrade shall be examined critically; and any areas discovered which are soft and unstable or exhibit other unusual conditions, shall be immediately pointed out to the Testing Agency. Upon the direction of the Testing Agency, these areas shall be excavated to such depths as may be necessary to insure satisfactory supporting properties. These areas of excavation shall be backfilled immediately and shall be brought to the elevation of the surrounding area with suitable material in accordance with the embankment construction procedure. Removal of unsuitable material and its replacement as directed shall be paid on basis of contract conditions relative to changes in work.
 - 6. In general, subgrade shall be established at the following levels:
 - a. For Pavement Areas: Finish grade less the thickness of pavement and base material.

- b. For Structures: Finish floor elevation less the thickness of the slab and any porous fill.
 - c. For Lawn Areas: Finish grade less a minimum 6 inches topsoil thickness.
 - d. Sidewalks and Plazas: Finish grade minus sidewalk and base thickness.
 - e. Landscape Areas: Finish grade less topsoil and mulch. Refer to "Schedule of Locations" Section for topsoil depths. Refer to "Schedule of Locations" Section for mulch depths.
- B. Compaction and Proof Rolling of Subgrade:
 - 1. All subgrade surfaces shall be proof rolled by means of heavy equipment (minimum 30 ton dual axle truck dump) to locate and permit timely correction of the subgrade deficiencies. Proof rolling shall be witnessed by the Testing Agency.
 - 2. In cut sections, proof rolling of the subgrade surface shall be done to determine the location and extent of areas below subgrade surface that may require subgrade undercutting. Should any portion of the cut subgrade surface fail to provide satisfactory support for the proof rolling operation, the Testing Agency may order corrective undercut and backfill work done. Corrective undercut and backfill will be paid for as specified in 3.04 A.5.
 - 3. In embankment sections, prior to placing the embankment, proof rolling on the subgrade surface shall be done to determine the uniformity of the compaction below the subgrade and any deficiencies requiring corrective work. Any deficiencies discovered during proof rolling operations shall be corrected in a manner satisfactory to the Testing Agency. Corrective undercut and backfill will be paid for as specified in 3.04 A.5. After all corrective work has been completed, the surface shall be proof rolled again. Corrective work shall not be considered complete and acceptable until the embankment shows satisfactory and uniform response to the proof rolling operations.
- C. Embankment:
 - 1. After proof rolling of the existing subgrade has been completed, the surface of the area to be filled shall be scarified to a depth of 6 inches. An initial 3 inch layer of fill material shall then be spread over the scarified surface and the entire area compacted as specified.
 - 2. Areas requiring fill shall be filled and backfilled using suitable materials compacted in layers not to exceed the following (all thicknesses are loose thicknesses):
 - a. Within building areas - 8 inches.
 - b. Under pavements, sidewalks, or plazas - 8 inches.
 - c. General site fill - 12 inches.
 - 3. The moisture content of placed material shall not deviate from the optimum by more than two percent (+/-2%). Moisture content of any material which displays pronounced deformation under construction equipment shall not exceed the optimum. Drying of wet soil shall be expected by the use of plows, discs, harrows, or other approved methods. If additional water is required, it should be uniformly distributed through the use of approved water wagons and shall be thoroughly incorporated into the material by means of discs or other suitable mixing equipment. Care shall be taken to avoid trapping water within the fill.
 - 4. Amount of Compaction: After each layer has been placed, mixed, and spread evenly, it shall be thoroughly compacted to not less than the percent shown under the Compaction Requirements Schedule in accordance with ASTM Method D-698 at a moisture content of $\pm 2\%$ of optimum.

5. **Compaction of Embankment Layers:** Compaction equipment shall be of such design that it will be able to compact the fill to the specified density. Compaction of each layer shall be continuous over its entire area and the compaction equipment shall make sufficient trips to ensure that the required density has been obtained.
6. **Density Tests:** Field density tests shall be made by the Testing Agency per the Compaction Requirements Schedule. Density tests shall be taken in compacted material below the disturbed surface. When these tests indicate that the density of any layer of fill or portion thereof is below the required density, the particular layer or portion shall be reworked until the required density has been obtained.
7. **Seasonal Limits:** No fill material shall be placed, spread, or rolled while it is frozen or thawing or during unfavorable weather conditions. When the work is interrupted by heavy rain, fill operations shall not resume until the Testing Agency indicates that the moisture content and density of the previously placed fill are as specified.
8. The embankment and borrow areas should be maintained in a freely draining condition at all times. Proper drainage should be provided for any water or springs which may be encountered.
9. When the embankment meets the natural grade of a slope, a bench shall be cut in the existing slope. These cuts are to serve as keys to connect the existing grade with the newly placed fill.
10. Frozen fill material or any suitable fill shall not be placed on frozen or snow covered surfaces.
11. If soft, yielding material is encountered in embankments as a result of trapping water, and cannot be satisfactorily stabilized by moisture control and compaction, the unstable material shall be excavated to the depth required by the Testing Agency. The excavation shall then be filled with suitable material and compacted in accordance with the requirements outlined above.
12. **Rock:** When fill material includes rock, the maximum rock size acceptable shall be 6 inches. No large rocks shall be allowed to nest, and all voids must be carefully filled with small stones or earth, properly compacted. No large rocks will be permitted within 12 inches of the finished grade.
13. **Rock – Rock fill** shall be placed in not to exceed 3 foot thick horizontal lifts. Rock which cannot be incorporated into lifts of 3 feet shall be reduced in size until it can be so incorporated. Lifts made up principally of small rock shall be rolled in a similar manner as that required for shale and siltstone. Beneath the footprints and 5 foot perimeter of the proposed buildings, the top 3 feet of fill embankment shall be constructed of a non-organic soil fill. Beneath proposed pavements, the top 1 foot shall consist of a soil fill. Maximum rock size shall be 18 inches.
14. When embankment is to be placed and compacted on hillsides or where new embankment is to be compacted against existing embankments, slopes that are steeper than 8:1 shall be continuously benched over those areas where it is required as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment.

3.05 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, relandscaped, or regraded and stockpile in area designated on site. Seed stockpile in accordance with Section 31 25 00, "Erosion and Sediment Control."

3.06 EXCAVATION

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Excavate subsoil and whatever material encountered required to accommodate building foundations, slabs-on-grade, paving and site structures, and construction operations.
- C. Machine slope banks.
- D. Excavation cut not to interfere with normal 45 degree bearing splay of foundation.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- F. Hand trim excavation. Remove loose matter. Compact bottoms of excavations with a plate vibrator if so directed by the Testing Agency. All excavations to be protected as work progresses.
- G. Remove lumped subsoil, boulders, and rock greater than 1/3 cubic yard measured by volume.
- H. Notify Architect/Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- I. Correct unauthorized excavation at no extra cost to Owner.
- J. Correct areas over-excavated by error at no extra cost to the Owner.
- K. Remove all excavated material from within building area.
- L. Contractor solely responsible for means and methods employed to excavate materials encountered on site.
- M. It is intent of Contract Documents that excavation cuts be used as forms for vertical surfaces of footings and column pads. Soil conditions which prevent vertical cuts, or excavation characteristics which require forming concrete are responsibility of General Trades Contractor.
- N. Prior to placing concrete for the footings, all foundation excavations shall be inspected and approved by the Testing Agency, for the bearing capacity indicated on the Drawings.

3.07 BUILDING FILL AND BACKFILL

- A. Remove any accumulated debris from excavations before backfilling.
- B. Backfill on interior side of perimeter footings and foundation walls and on both sides of interior footings and foundation walls with Type A or Type H fill. Place in 8 inch layers, compact with vibratory compaction equipment to 98% of the maximum dry unit weight.
- C. Construct gravel base under floor slab of Type A, Type E, or Type H fill within building area to provide a layer of minimum 4 inch thickness. Shape subgrade and gravel base for floor slab construction per Drawings.

- D. Within all areas to receive asphalt or concrete pavement immediately adjacent to exterior walls, backfill on exterior of foundation walls with Type A, Type H, Type J, or Type K fill. Place in 8 inch layers, compact with vibratory compaction equipment to 98% of the maximum dry unit weight.
- E. Backfill at all other exterior foundation walls with suitable excavated material. Place material in 8 inch layers and compact to 98% of the maximum dry unit weight. Backfill to level slightly above grade at building exterior to drain water away from building. At walls with foundation drains and/or weep holes, provide Type A or Type H material for extent indicated on structural drawings. Place material in 8 inch layers and compact to 98% of the maximum dry unit weight. In lawn areas, place a 2 foot cohesive clay cap from the bottom of the topsoil to a depth of 2 feet.
- F. Exercise caution to avoid damage to foundation damp proofing during backfill and compaction operations.

3.08 SUBSOIL PREPARATION FOR PLACING TOPSOIL

- A. Eliminate uneven areas and low spots. Remove debris, roots, branches, stones, in excess of 2 inches in size. Remove subsoil contaminated with petroleum products.
- B. Scarify subgrade to depth of 6 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.09 PLACING TOPSOIL

- A. Place topsoil in areas where seeding, sodding, and planting is scheduled.
- B. Use topsoil in relatively dry state. Place during dry weather.
- C. Fine grade topsoil eliminating rough or low areas. Maintain levels, profiles, and contours of subgrade.
- D. Remove stone, roots, grass, weeds, debris, and foreign material while spreading.
- E. Manually spread topsoil around trees, plants, building and curbs to prevent damage.
- F. Roll placed topsoil.
- G. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.10 SCHEDULE OF LOCATIONS

- A. The following paragraphs identify compacted topsoil thicknesses for various locations.
 - 1. Seeded Areas: 6 inches minimum
 - 2. Sod: 6 inches minimum
 - 3. Shrub Beds: 18 inches minimum
 - 4. Flower Beds: 12 inches minimum
 - 5. Planter Boxes: To within 3 inches of box rim

3.11 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed by an independent Testing Agency retained by the Contractor and approved by the Owner.
- B. Tests and analysis of fill material will be performed in accordance with ASTM D698 and with Division 1.
- C. Compaction testing will be performed in accordance with ANSI/ASTM D2922 and D3017 and with Division 1.
- D. Field density test reports shall clearly identify the following information for each test:
 - 1. Horizontal and vertical location of test
 - 2. Material type being tested
 - 3. Proctor test method
 - 4. Maximum proctor density
 - 5. Specified density
 - 6. Optimum moisture content
 - 7. Field test method
 - 8. Actual moisture content
 - 9. Tested density
 - 10. Pass/fail indication
- E. Do not submit reports of failing tests without follow-up report of reworked area and passing retest. Submitted test reports without specified information will be returned for revisions and resubmittal.
- F. Submit rough draft of daily Field Observation Report to the Engineer via facsimile the day of the field visit. Follow up with formal report.
- G. Excavate, replace at near optimum moisture, recompact and retest all areas failing to meet compaction requirements at no additional cost.

3.12 SCHEDULE OF FILL MATERIAL AND COMPACTION REQUIREMENTS SCHEDULE

- A. Compact fill materials to meet the following minimum Standard Proctor Density, ASTM D698.

LOCATIONS	MATERIAL TYPES												COMPACTION REQUIREMENTS		
	A I T E M 4 1 1	B P E A G R A V E L	C S A N D	D S U B S O I L	E I T E M 7 0 3 5 7	F T O P S O I L	G C O N C R E T E	H I T E M 7 0 3 8	I C D F	J I T E M 3 0 4	K B A N K R U N G R A V E L	L N S D B	% C O M P A C T I O N	M I N I M U M T E S T	U N I T A R E A / L I F T
Aggregate base under exterior concrete slabs, sidewalks, and plaza areas.	X									X		X	98%	1/1000 SY	
Foundation wall backfill as defined in "Building Fill & Backfill."	X							X					98%	1/100 SY	
Areas to receive asphalt or concrete pavement or walks immediately adjacent to exterior walls.	X							X		X	X		100%	1/500 SY	
Aggregate base beneath interior floor slab.	X				X			X					100%	1/500 SY	
General site fill, both paved and non-paved areas, utility trenches outside paved areas, utility trenches under pavement in excess of 48 inch depth, corrective backfill, areas to receive lawns immediately adjacent to exterior walls.													98%	1/1000 SY	
Sewer bedding.				X	X								N/A	N/A	
Underdrains, french drains, aggregate drainage material behind site retaining walls.					X			X					N/A	N/A	
Abandoned utilities, trench backfill where shown on drawings.									X				N/A	N/A	
Utility trenches less than or equal to 48 inch depth under pavement.	X									X			100%	1/300 LF	
Aggregate base beneath asphalt roads.										X			100%	1/500 SY	
Fill beneath floor slabs and aggregate base or foundations, corrective backfill for over excavation, or fill for removed foundations.	X			X						X	X	X	100%	1/50 SY	
Finish slopes, lawn areas, planters.						X							N/A	N/A	
Sewer Encasement							X								

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Remove surface debris.
- B. Clear site of plant life and grass.
- C. Remove trees and shrubs.
- D. Remove root system of trees and shrubs.

1.02 RELATED SECTIONS

- A. Section 31 00 00, "Earthwork"

1.03 REGULATORY REQUIREMENTS

- A. Conform to applicable code for disposal of debris.
- B. Coordinate clearing Work with utility companies.
- C. Contractor to dispose of removed trees off site.

1.04 DEFINITIONS - The following definitions govern site preparation, clearing, and demolition operations.

- A. Clearing: Removal and disposal of all site vegetation.
- B. Demolition: Removal and disposal of an existing constructed site element in its entirety both above and below grade or unless otherwise indicated on the Drawings.
- C. Trees: Plant material having a trunk diameter of 3 inches or larger measured 1 foot above the ground. Multi-stemmed trees are considered as one tree.
- D. Bush and/or Vegetation: Plant material having a stem diameter less than 3 inches at any point between grade and 1 foot above grade.
- E. Debris: Any material such as rubbish, concrete, bricks, fencing, culverts, windfalls, decaying matter, ash, etc., including materials generated from the demolition of existing structures, surface materials, utilities and brush and tree removal.
- F. Structure: All connected parts of a constructed object to its full extent both above and below grade.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that existing plant life and features designated to remain are tagged and identified.

3.02 PROTECTION

- A. Protect utilities that remain, from damage.
- B. Protection of Existing Trees, Landscaping and Natural Features:
 - 1. General Requirements: The Contractor shall protect, throughout the course of construction, all such trees as are shown on the Drawing or marked by the Owner's agent "to be saved."
 - a. The Contractor shall also protect throughout the course of construction all landscaping, vegetation, and natural features on public and private property. The Contractor shall use every precaution to prevent injury, damage, pollution, erosion or destruction of existing landscaping, vegetation, and natural features, including drainage ways, ponds, lakes, swamps, woods and fields.
 - 2. The limits of clearing shall be located outside the drip line of any tree to be retained, and in no case closer than 5 feet to the trunk of such a tree.
 - 3. Marking: Prior to construction and before the preconstruction conference, individual trees and stands of trees to be retained within the limits of clearing shall be visibly marked with a bright color paint or surveyor's ribbon applied in a band circling the tree at a height visible to equipment operators.
 - 4. Pre-Construction Conference: During any preconstruction conference, tree preservation and protection measures should be reviewed with the Contractor as they apply to that specific project.
 - 5. Equipment Operation and Storage: Heavy equipment, vehicular traffic, or stockpiles of any construction materials including topsoil shall not be permitted within the drip line of any tree to be retained. Trees being removed shall not be felled, pushed or pulled into trees being retained. Equipment operators shall not clean any part of their equipment by slamming it against the trunks of trees to be retained.
 - 6. Fires: Fires shall not be permitted within 100 feet from the drip line of any trees to be retained. Fires shall be limited in size to prevent adverse effects on trees and kept under surveillance.
 - 7. Storage and Disposal of Toxic Materials: No toxic materials shall be stored closer than 100 feet to the drip line of any trees to be retained. Paint, acid, nails, gypsum board, wire, chemicals, fuels, and lubricants shall not be disposed of in such a way as to injure vegetation.
 - 8. Fencing and Armoring: Any device may be used which will effectively protect the roots, trunk and tops of trees retained on the site. However, trees to be retained within 40 feet of a proposed building or excavation shall be protected by fencing. Personnel must be instructed to honor protective devices. The devices described are suggested only and are not intended to exclude the use of other devices which will protect the trees to be retained.
 - a. Snow Fence - Standard 40 inch high snow fence shall be placed at the limits of clearing on standard steel posts set 6 feet apart.

- b. Board Fence - Board fencing consisting of 4 inch square posts set securely in the ground and protruding at least 4 feet above the ground shall be placed at the limits of clearing with a minimum of two (2) horizontal boards between posts. If it is not practical to erect a fence at the drip line, construct a triangular fence nearer the trunk. The limits of clearing will still be located at the drip line since the root zone within the drip line will still require protection.
- c. Cord Fence - Posts with a minimum size of 2 inches square or 2 inches in diameter set securely in the ground and protruding at least 4 feet above the ground shall be placed at the limits of clearing with two (2) rows of cord 1/4 inch or thicker at least 2 feet apart running between posts with strips of colored surveyor's flagging tied securely to the string at intervals no greater than 3 feet.
- d. Earth Berms - Temporary earth beams shall be constructed according to Specifications for a TEMPORARY DIVERSION DIKE (Specification 31 25 00, Paragraph 3.08) with the base of the berm on the tree side located along the limits of clearing. Earth berms may not be used for this purpose if their presence will conflict with drainage patterns.
- e. Additional Trees - Additional trees may be left standing as protection between the trunks of the trees to be retained and the limits of clearing. However, in order for this alternative to be used, the trunks of the trees in the buffer must be no more than 6 feet apart to prevent passage of equipment and material through the buffer. These additional trees shall be reexamined prior to the completion of construction and either given sufficient treatment to ensure survival or removed.
- f. Trunk Armoring - As a last resort, a tree trunk can be armored with burlap wrapping and 2 inch studs wired vertically no more than 2 inches apart to a height of 5 feet encircling the trunk. If this alternative is used, the root zone within the drip line will still require protection. Nothing should ever be nailed to a tree.
- 9. Fencing and armoring devices shall be in place before excavation or grading is begun, shall be kept in good repair for the duration of construction activities, and shall be the last items removed during the final cleanup after the completion of the project.
- 10. Grading and/or Filling Around Trees: Grading and/or filling operation within the protective fencing shall be carried on with extreme care only under the direct supervision of the Architect. If the soil over the root area of the trees has been compacted, it shall be restored by proper cultivation to permit entrance of water and proper aeration of roots.
- 11. Cutting of Tree Roots and Limbs: Roots and limbs of trees are not to be cut unless authorized by the Owner's agent. Should it become necessary to do so, the Contractor shall treat the remaining exposed portion of roots and/or limbs to prevent damage, loss or injury to the tree. This treatment shall be done in accordance with accepted horticulture practice and by personnel experienced in that field of work.

C. Protect benchmarks and existing structures from damage or displacement.

D. Repair damage.

3.03 CLEARING

A. Clear areas shown on Drawings for access to site and execution of work.

B. Remove trees and shrubs indicated. Remove stumps and root system to a depth of 24 inches.

C. Clear undergrowth and deadwood without disturbing subsoil.

- D. Apply herbicide to remaining stumps to inhibit growth.
- E. In locations which will be a minimum of 3 feet below subgrade or slope of embankment, the Contractor may leave undisturbed stumps and roots and nonperishable solid objects provided they do not extend more than 6 inches above the ground surface.

3.04 REMOVAL

- A. Remove debris, rock, and extracted plant life from site.

3.05 EROSION AND SEDIMENT CONTROL

- A. Comply with all requirements of Section 31 25 00, "Erosion and Sediment Control." Execute all appropriate indicated or otherwise required erosion and sediment control items prior to clearing and/or demolition activities. Execute any remaining erosion/sediment items as soon as practical after clearing operations. Conform to the requirements of the local authority.

END OF SECTION

SECTION 31 21 13

RADON MIDIGATION

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, equipment and service necessary to complete all work involved in radon mitigation.
- B. Provide all work necessary to reduce and maintain radon concentration levels below radon levels required] in various buildings specified herein. Perform mitigation system installation, and perform post-mitigation testing and monitoring for radon.

1.02 RELATED SECTIONS

- A. Electrical: Division 26.
- B. Plumbing: Division 22.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Regularly engaged in radon mitigation work for a minimum of 5 years.

1.03 SUBMITTALS

- A. Product Data: Submit for all items.

PART 2 PRODUCTS

2.01 MATERIALS

- A. See following attached Radon Mitigation Harriet's Hope Project Specification and products,

PART 3 EXECUTION

3.01 PREPARATION

- A. Examine conditions of substrates and installation conditions. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Verify and coordinate mechanical and electrical services.

3.02 INSTALLATION

- A. See Radon Mitigation Project Specification
- B. Install all components and system per manufacturers recommendations.
- C. Route radon mitigation systems piping so as not to interfere with the daily operations and functions of the building occupants. Keep visibility of the systems to a minimum. Enclose each radon mitigation system in occupied spaces, however, all operating components must be accessible for maintenance and repair.
- D. Mitigation system discharge points must be as specified in ANSI/AARST RMS-LB and EPA 402-R-93-078.
- E. Test each radon mitigation system for effectiveness after activation of the radon mitigation system. Perform all testing in accordance with ANSI/AARST MALB, and all local, state and Federal requirements.

END OF SECTION

Radon Mitigation System – Harriet’s Hope

I. SPECIFICATIONS To Meet The ANSI/AARST CC-1000-2018 Soil Gas Control Systems in New Construction of Buildings

1. The Radon Mitigation System (SSDS) shall be installed with an air channeling material, such as VaporMat or an engineered equivalent under the concrete slab of the facility. The air channeling material shall be installed around the entire inside perimeter of the foundation footer within 2-4', as well as cross sections every 20' across the entire length of the building. As Needed additional air channeling lines shall run across the width of the building connecting the extraction point locations. Recommend the air channeling material to be installed on top of the last layer of backfill, right before the vapor barrier is installed and the slab is poured. Specifically, VaporMat air channeling material can be installed under footers/thickened slabs. See drawing for proposed layout and the manufacturer's spec. sheet for reference and installation guidelines.
2. The SSDS will consist of four, 4-inch solid SCH-40 PVC pipe running vertically up through a designated wall chase through the flat roof. Recommend roofing contractor to seal roof penetrations. See drawing for proposed location.
3. The sub slab vent piping and the vertical riser piping of the SSDS shall be 4-inch diameter SCH-40 PVC piping. All joints and fittings should be properly chemically bonded/sealed following manufacturer instructions.
4. The contractor shall create a pit underneath the slab at each suction point by excavating approximately 1 cubic foot (approximately 5-10 gallons) from around the vent riser pipe. Recommend a radon "T" or engineered equivalent to be used to create each suction point under the concrete slab.
5. All joints in and penetrations through the slab shall be sealed against air leakage to include openings around plumbing, SSDS vent pipes, mechanical piping, structural components, electrical conduit, and any other gaps that are open to the soil or gas permeable layer. Sealing of penetrations shall be achieved with caulk that complies with ASTM C920 class 25 or higher, closed cell gasket materials, or an equivalent method. If caulk is used to seal a crack, joint, or opening greater than ½ inch in width, foam backer rod or other comparable filler material shall be inserted into the joint to support the caulk as it cures.
6. PVC pipe joints shall be solvent welded in accordance with the pipe manufacturer's instructions with solvent cement conforming to ASTM D2564.

7. Vertical risers must be supported in accordance with minimum standards established by local plumbing codes and must be supported vertically not less than every 10 feet and 4 to 6 feet horizontally. All supports shall inhibit both lateral and vertical movement of piping that could result in compromised joint collections/water traps and avoid locations that are susceptible to damage or blunt force impact.
8. Vertical riser piping shall be visibly labeled "Radon Mitigation System Vent Pipe" on each floor level of the building. The lowest label shall be placed at eye level.
9. The venting terminus of the riser pipes shall terminate a minimum of 24 inches above the flat roofline. Recommend installing a Varmint Guard screen or engineered equivalent on top of each vent riser.
10. Riser pipe exhausts shall be spaced a minimum 20 feet from any opening in the building (doors, windows, ventilation, air intakes, etc.) or exterior flooring (decks, sidewalks, balconies, etc.) or must be a minimum of 10 feet above or horizontally from the building openings or exterior flooring.
11. As necessary or requested, the passive radon vent risers shall be activated with an approved radon mitigation fan unit based on air pressure field diagnostics and pressure readings from U-tube manometers. Recommend RadonAway's RP 265 Fan, or an engineered equivalent.
12. The radon mitigation fan requires an on and off disconnect switch within 6 feet of each fan's location on the roof top. A licensed electrician shall provide a continuous power source for each radon fan. See manufacturer's spec. sheet for electrical information for the model of fan installed.
13. A system O&M plan shall be provided to the property owners. As necessary, install a fan failure indicator (U-tube Manometer Or Magnehilic Manometer), on the vent riser. Fan failure indicator must be placed somewhere in an accessible and visible location below the fan.
14. If applicable, sump pits or other pit openings in interior floors that connect to sub slab air and require access for maintenance shall have a rigid lid that is sealed with a gasket material or silicone caulk and mechanically fastened in a manner to facilitate removal. The sump lid shall be made of sturdy and durable plastic such as polycarbonate plastic and designed to support any anticipated load on the lid. Penetrations through the lid (if any) shall be sealed with a caulk complying with ASTM C920 class 25 or higher (or equivalent). Sump lids shall be labeled "Component of Vapor Mitigation System" and "Return to a Closed Condition if Opened, Accessed, or Damaged". Labels shall be placed on the sump lid.

15. Note to the General Contractor, a soil gas retarder or vapor barrier is required to completely cover the area beneath the concrete slab. The soil gas retarder or vapor barrier shall be placed between the gas permeable layer and the concrete slab. The soil gas retarder or vapor barrier shall be polyethylene sheeting no less than 6 mils in thickness.
16. The SSDS installation should be performed by a licensed O.D.H. radon contractor. If vent risers are activated, a licensed radon mitigation specialist must install the appropriate fan units.
17. An indoor short term radon test to meet current Ohio Department of Health guidelines shall be performed once the facility is in livable conditions. A licensed radon contractor shall perform the test. Testing shall be performed in accordance with applicable state or local requirements.

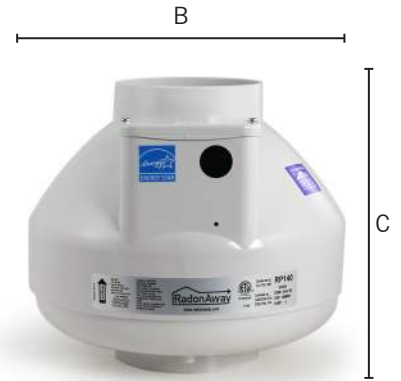
INSTALLS WHITE, STAYS WHITE

Radon Mitigation Fan

All RadonAway® fans are specifically designed for radon mitigation. RP Series Fans provide superb performance, run ultra-quiet and are attractive. They are ideal for most sub-slab radon mitigation systems.

Features

- NEW Stay-White™ housing
- Energy efficient
- RP140 - ENERGY STAR Most Efficient 2017
- Ultra-quiet operation
- Meets all electrical code requirements
- Water-hardened motorized impeller
- Seams sealed to inhibit radon leakage (RP140 & RP145 double snap sealed)
- ETL Listed - for indoor or outdoor use
- Thermally protected motor
- Rated for commercial and residential use



MODEL	P/N	FAN DUCT DIAMETER	WATTS	RECOM. MAX. OP. PRESSURE "WC	TYPICAL CFM vs. STATIC PRESSURE WC				
					0"	.5"	1.0"	1.5"	2.0"
RP140	28460	4"	15-21	0.7	135	70	-	-	-
RP145	28461	4"	41-72	1.7	166	126	82	41	3
RP260	28462	6"	47-65	1.3	251	157	70	-	-
RP265	28463	6"	91-129	2.2	334	247	176	116	52
RP380*	28208	8"	95-152	2.0	497	353	220	130	38

*Currently not stay-white material.



Made in USA with U.S. and imported parts.



ETL Listed



All RadonAway® inline radon fans are covered by our 5-year, hassle-free warranty.



Model	A	B	C
RP140	4.5"	9.7"	8.5"
RP145	4.5"	9.7"	8.5"
RP260	6"	11.75"	8.6"
RP265	6"	11.75"	8.6"
RP380	8"	13.41"	10.53"

For Further Information, Contact Your Radon Professional:



VAPORMAT™ FOR RADON, MOISTURE AND VOC REDUCTION



- SAVES TIME & MONEY
- EASY TO INSTALL
- >40% RECYCLED PRE-CONSUMER MATERIAL
- LEED V4 CREDIT ELIGIBLE (1-2 POINTS)
- COMPLIES W/RRNC 2.0 & ASTM E-1465





MEETING THE STANDARDS WITH VAPORMAT™

RADON REDUCTION IN NEW BUILDING CONSTRUCTION

New construction radon standards, including the U.S. EPA-recommended ANSI-AARST Standard, RRNC 2.0: Reducing Radon in New Construction of 1 & 2 Family Dwellings and Townhouses, call for the installation of a soil gas collector beneath the slab.

An increasing number of mitigation and construction contractors are using soil gas collector matting, choosing it for its ease of installation. In addition, RRNC 2.0 (Section 402.1.1.2) recommends its use and further states: “The *soil gas collector* shall consist of a strip of geotextile drain matting not less than 10 feet [3 m] in length and having a cross sectional area of not less than 12 square inches [77 sq. cm]. The strip of matting shall be placed on top of the soil or in a trench.”

VAPORMAT, available in 0.5-inch and 0.9-inch thicknesses, meets and exceeds RRNC 2.0 and other standards for the collection of radon, moisture, and other toxic vapors that come from beneath the slab. It works effectively with both passive and active soil depressurization systems.

VAPORMAT™ INFORMATION AND SPECIFICATIONS

The matting is enveloped in the filter fabric and is comprised of 90% air space, allowing the radon and other soil gases and vapors to be channeled to the riser pipe connection tee. Two sizes of VAPORMAT™ are available: 040-48 and 080-15.

VAPORMAT™	040-48	080-15
Thickness	0.4 inches	0.8 inches
Width	48 inches	15 inches
Roll Length	50 feet	45 feet
Rolls per Pallet	10	24
Compressive Strength	>2,500 PSF ¹	>2,500 PSF*
Determined Flow Rate	11.856 gallons/Min./Ft. ²	11.856 gallons/Min./Ft. ²
Percent Recycled	>40% (Pre-Consumer Material)	>40% (Pre-Consumer Material)

¹ Concrete Slab typically 30-60 PSF

² Per ASTM 4716



VAPORMAT™ APPLICATIONS:

- Typically used in place of perforated piping for negative pressure field extension under a concrete slab or radon vapor barrier.
- Where a pressure field is required across obstacles or over distances.
- In conjunction with sand and/or gravel.

BENEFITS / FEATURES:

- Reduces radon, moisture and other toxic vapor levels in the living space of a home when used in conjunction with an active fan.
- Reduces the potential for mold and mildew problems when used in conjunction with an active fan.
- Maintains air flow communication across grade beams, downturns, footers and distant corners when used in conjunction with an active fan.
- Reduces the need for an exhaust fan or basement dehumidifier reducing lifetime energy costs when used in conjunction with an active fan.
- Installation is easy saving time and money over other options.
- Complies with standards and building codes: IRC Appendix F, RRNC 2.0 and ASTM E-1465.
- Manufactured in USA.
- Shortens concrete slab cure time significantly when used in conjunction with an active fan.
- For pouring slabs in existing dirt floor basements or crawlspaces. The low profile of the VAPORMAT™ allows for less excavation when compared to placing perforated pipe in gravel.
- When used with Radon-T, allows for a more cost-effective solution as more expensive pipe connection fittings are not required.



INSTALLATION INSTRUCTIONS FOR VAPORMAT™ 080-15 (P/N 66106)

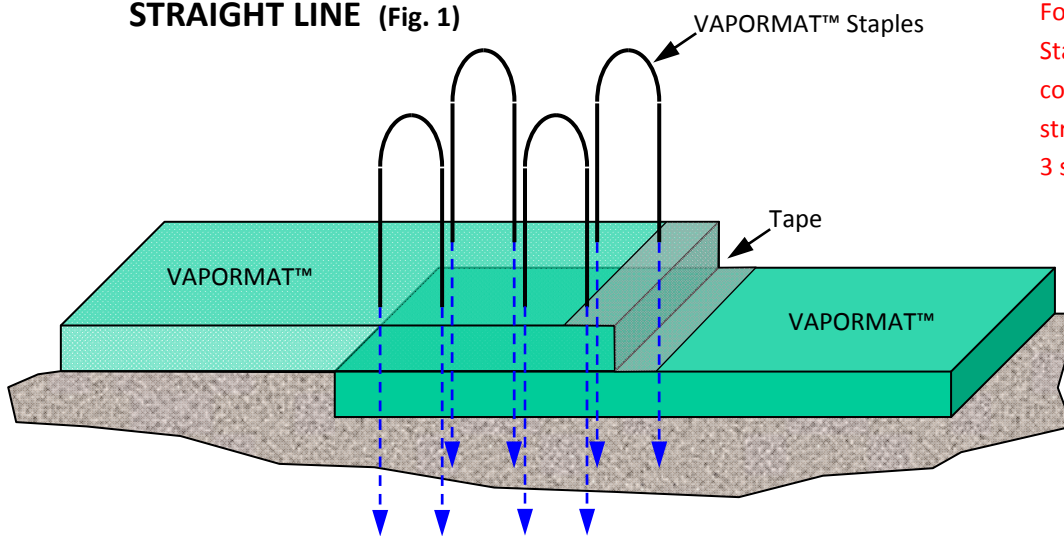
(See pages 5-8 for detailed drawings of VAPORMAT™ Installation.)

1. Roll out the VAPORMAT™ on the sub grade after the final preparation and before the concrete is poured. Typical layout is in the form of a rectangular loops in the largest areas with branches into the smaller areas. However, the actual layout will be dictated based on site specific dimensions and conditions.
2. Position the Radon-T in appropriate location and nail down through the molded in holes with the four (4) 6-inch steel spikes provided in the Radon-T Kit.
3. Lay the VAPORMAT™ over the Radon-T and cut a circular hole in the VAPORMAT™ where the riser pipe will be installed. Secure the VAPORMAT™ to the sub grade using RadonAway® VAPORMAT™ Staples (P/N 66107) or 6-inch steel spikes.
4. Roll out the VAPORMAT™, flatten it as much as possible onto the sub grade, stapling it to the ground as you roll it out. The VAPORMAT™ should be stapled to the ground every 3 to 4 feet, in addition to the splices, corners and “T” junctions.
5. Splices, corners and “T” junctions are connected by overlapping the VAPORMAT™ a minimum of length equal to or greater than the width (i.e., 15 inches). Staple through the upper and lower strips of the VAPORMAT™ strips, using a minimum of four staples at each corner—two to anchor the bottom and two to anchor the bottom layer into the sub grade. It is recommended that vapor barrier tape (RadonAway® P/N 68066 or 68017, or equivalent) be placed over the seam(s).
6. It is recommended that all openings in the fabric at splices, corners and “T” junctions of the VAPORMAT™ be taped (RadonAway® vapor barrier tape — P/N 68066 or 68017, or equivalent); however this is not required where the VAPORMAT™ will be overlain by a vapor barrier.
7. When the structure is ready for the soil gas vent pipe to be installed, the 4-inch plug is removed from the Radon-T and a 4-inch pipe is glued to the Radon-T. If vapor barrier is installed, tape should be used to attach to vertical pipe, then a bed of sealant should be applied around the pipe/barrier joint. This process also is used when VAPORMAT™ is used without vapor barrier.

DETAIL: CORNERS, "T" JUNCTIONS AND SPLICES

The mat should be routed around the inside perimeter of the foundation. This will require an occasional corner. Furthermore, splices will have to be made to join two lengths of mat together. Corners and splices are very easy to make, and do not require any special fittings. In the case of a splice, merely overlap one section over the other by a distance at least equal or greater than the width of the VAPORMAT™ (i.e., 15 inches) and anchor with four evenly spaced VAPORMAT™ staples (P/N 66107) by pushing through the overlapping VAPORMAT™ and into the subsurface. The seam should also be taped for added security, but is not required when vapor barrier is used over VAPORMAT™. Straight line, "T" junction and corner overlays are illustrated below.

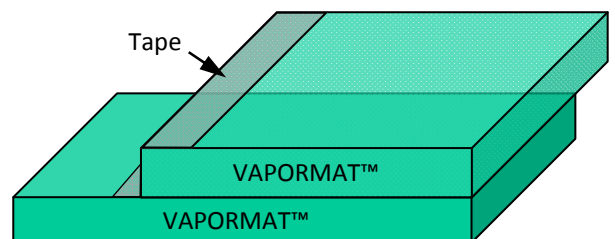
STRAIGHT LINE (Fig. 1)



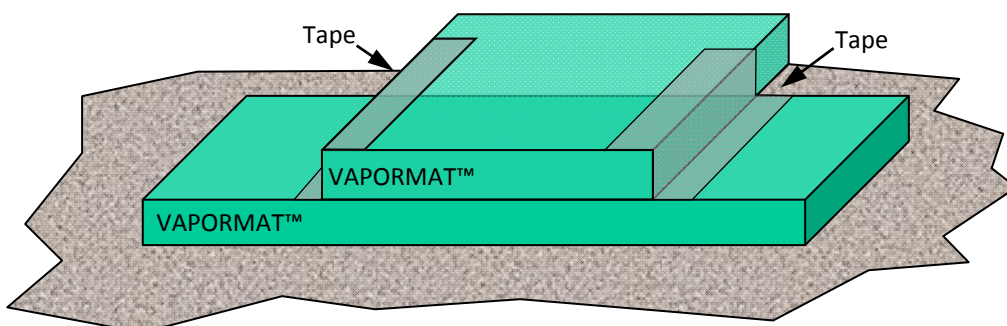
NOTE:

Four (4) or more VAPORMAT™ Staples should be used at all corners, "T" junctions and straight line splices (Figures 2 and 3 shown without staples)

CORNER (Fig. 3)



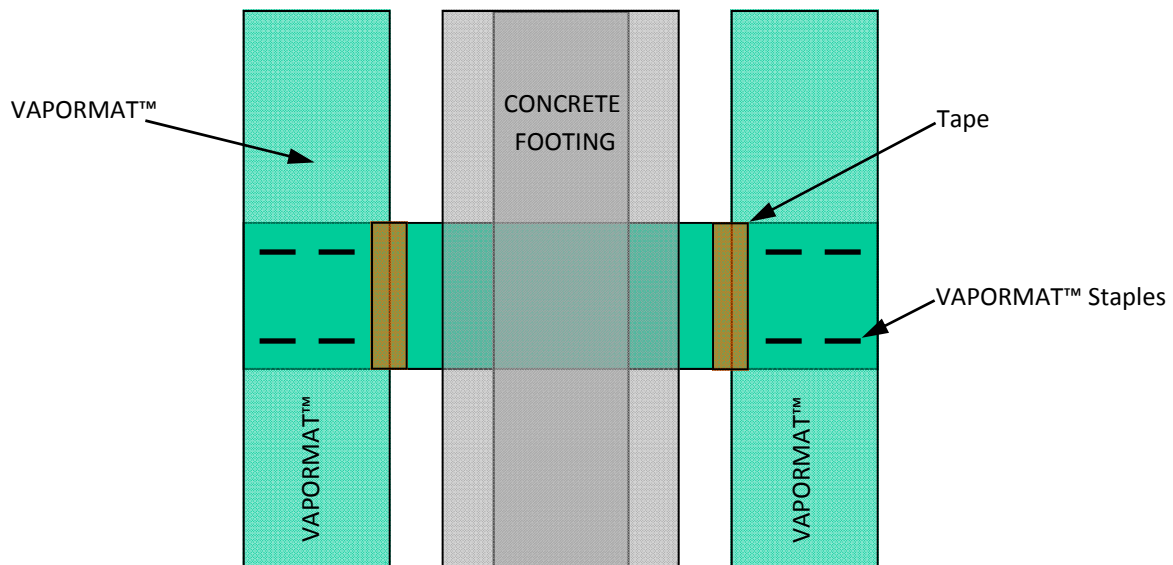
"T" JUNCTION (Fig. 2)



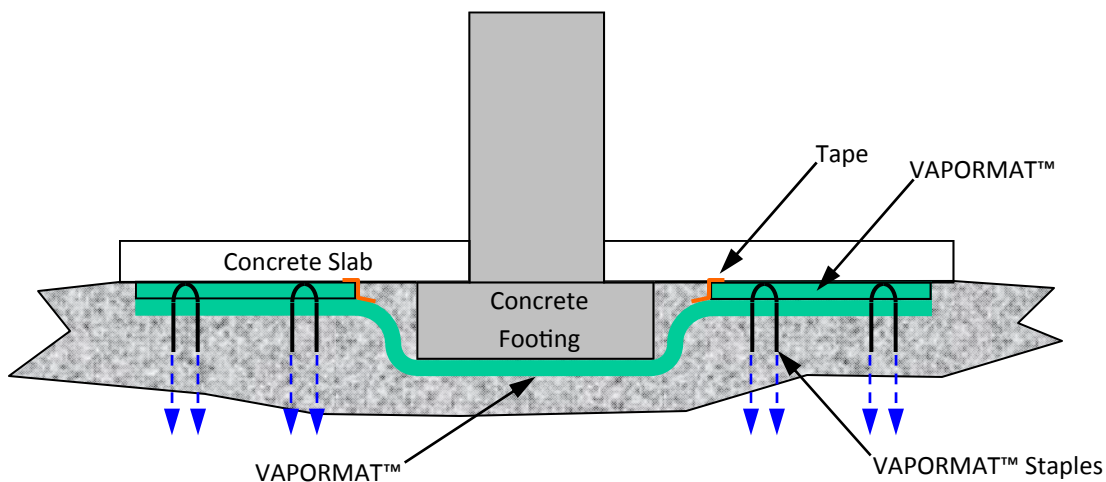
DETAILS: BRIDGING A FOOTING—METHOD 1

There are two methods which can be used to bridge a footing using the VAPORMAT™, laying the VAPORMAT™ beneath the footing or connecting to a horizontal pipe which cross-sections the footing wall.

METHOD 1: BENEATH FOOTING—OVERHEAD VIEW (Fig. 4)



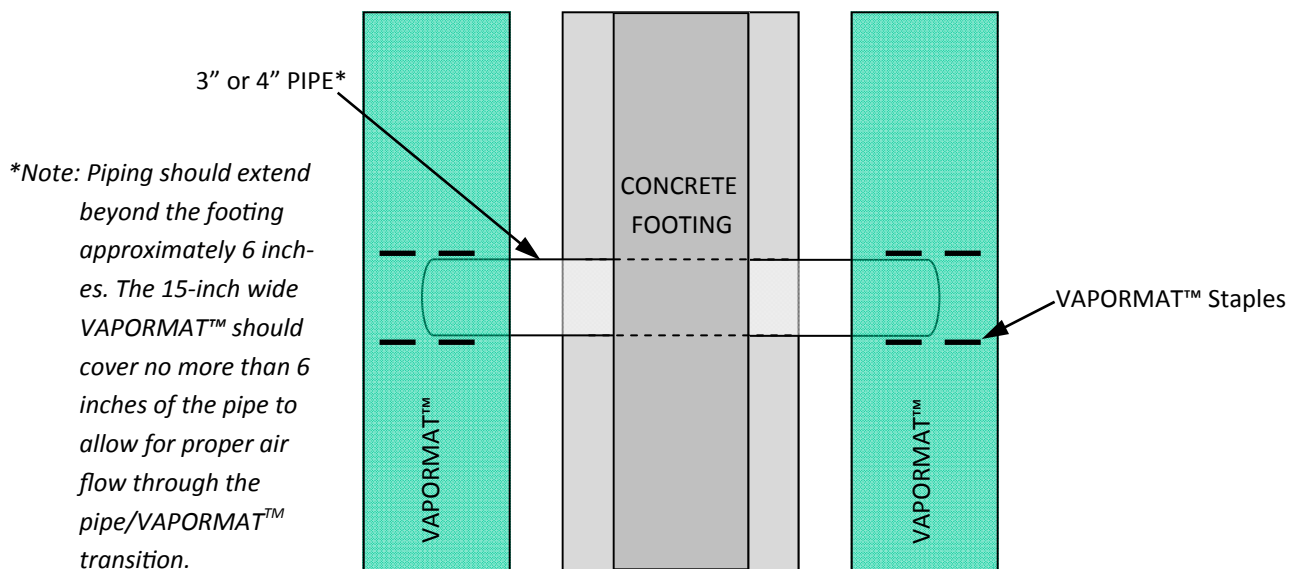
METHOD 1: BENEATH FOOTING—SIDE VIEW (Fig. 5)



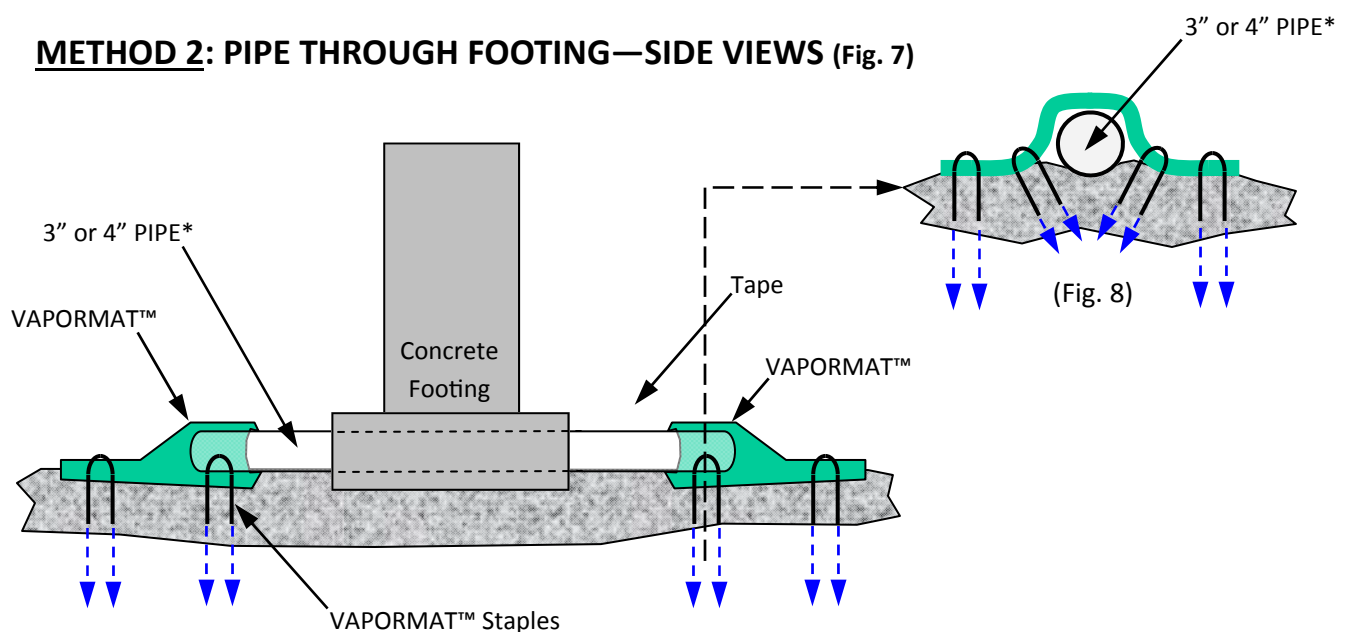
DETAILS: BRIDGING A FOOTING—MTEHOD 2

There are two methods which can be used to bridge a footing using the VAPORMAT™, laying the VAPORMAT™ beneath the footing or connecting to a horizontal pipe which cross-sections the footing wall.

METHOD 2: PIPE THROUGH FOOTING—OVERHEAD VIEW (Fig. 6)



METHOD 2: PIPE THROUGH FOOTING—SIDE VIEWS (Fig. 7)

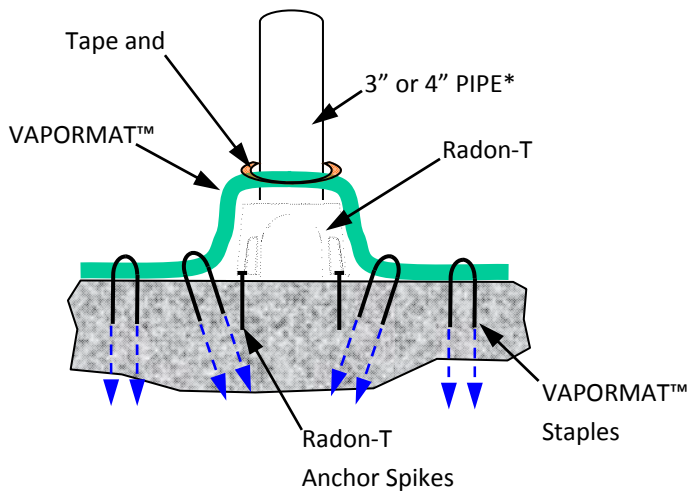




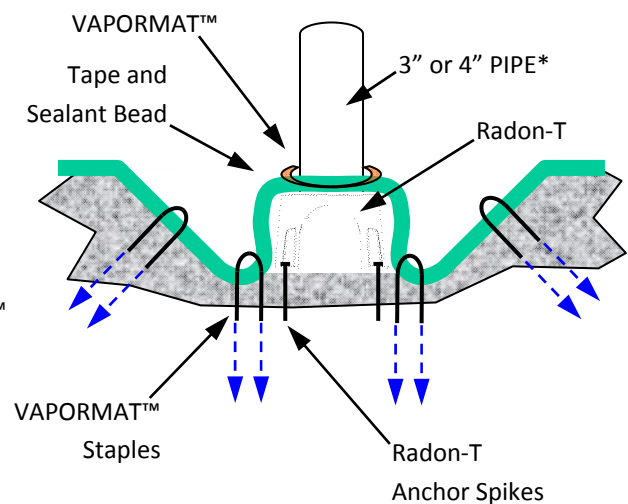
DETAIL: CONNECTING VAPORMAT™ TO RADON-T

The RadonAway® Radon-T replaces ordinary pipe fittings as a base for RRNC and crawlspace systems, the Radon-T saddles over perforated pipe, provides better air flow, prevents blockage by construction debris, and is ideal for use with VAPORMAT™.

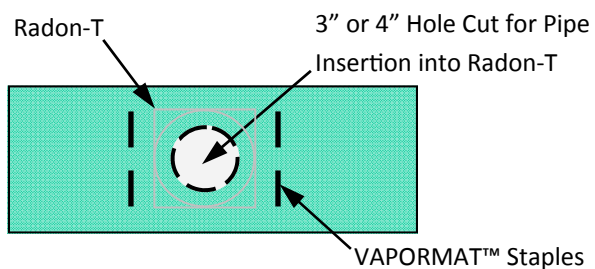
SIDE VIEW (Fig. 9)



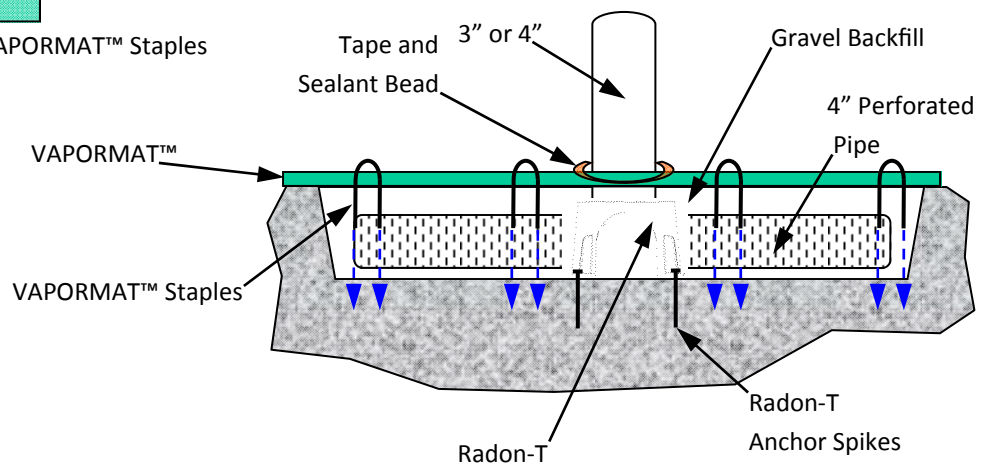
SIDE VIEW—FLUSH TO GRADE (Fig. 10)



OVERHEAD VIEW (Fig. 12)



SIDE VIEW—FLUSH TO GRADE WITH PERFORATED PIPING & STONE (Fig. 11)





DETAILS: POURING CONCRETE OVER VAPOR-MAT™

The filter fabric that is on the top and bottom of the VAPORMAT™ prevents soil, gravel and concrete from entering the material and reducing its air collection capacity. If vapor barrier is not used as an overlayment, care should be taken that the fabric is duct taped closed at splices sufficiently to keep the uncured concrete from entering.

The VAPORMAT™ also needs to be secured to the soil with RadonAway® VAPORMAT™ Staples (P/N 66107) to prevent the concrete from lifting it off the soil while it is being applied. Reinforcing bars and wire can be laid right on top of the VAPORMAT™ or vapor barrier (if present).

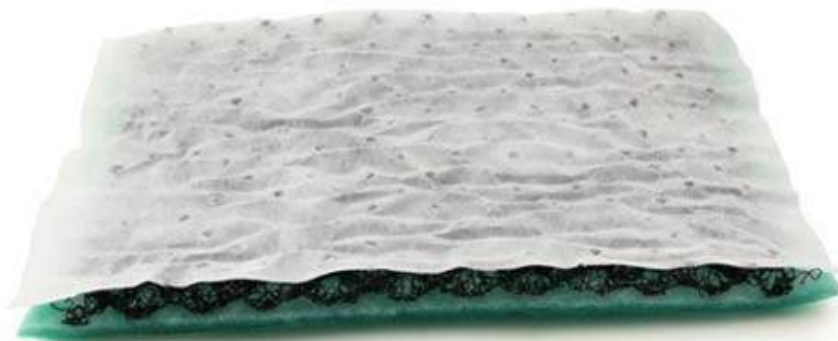


Shown covered with vapor barrier and metal mesh.

VAPORMAT™ is designed to be installed and work in the following conditions:

- Under concrete slab
- Under concrete slab and vapor barrier
- Or in conjunction with sand and/or gravel

VAPORMAT™ has a high compressive strength and performs well under compressive loads exceeding 2500 pounds per square foot; the load of a typical foundation slab is only 30 to 60 pounds per square foot. VAPORMAT™ provides maximum airflow and has an ASTM D 4716 determined flow rate of 11.856 gpm/ft. This high flow rate far exceeds the maximum rate at which ground air can flow through the soil from beneath the slab.





ACCESSORIES:



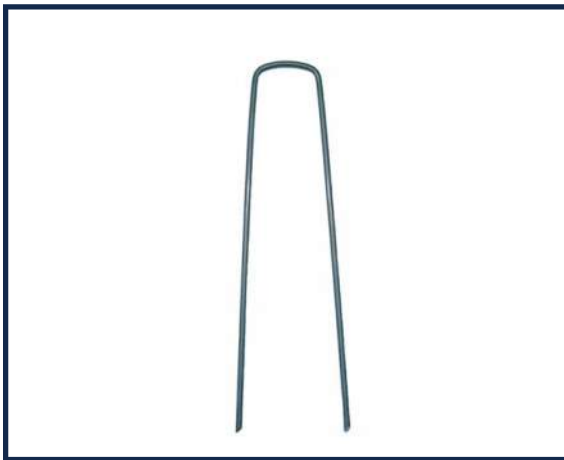
RADONAWAY® RADON-T

P/N 28353

P/N 28354 (Contractor Pack of 12)

Designed and manufactured by RadonAway® to replace ordinary pipe fittings as a base for RRNC and crawlspace systems, the Radon-T stabilizes the vertical pipe, saddles over perforated pipe, provides better air flow, and prevents blockage by construction debris. It is also ideal for use with VAPORMAT™.

Watch a Radon-T installation at radonaway.com/rrnc-t



VAPORMAT™ STAPLES

P/N 66107

These 6" x 1", 11 gauge steel staples are made specifically to secure VAPORMAT™ during installation.



TAPE:

P/N 68017 (Black 4" x 108' x 10 mil)

P/N 68066 (White 4" x 180' x 9 mil)

This barrier tape is recommended for use during installation to secure VAPORMAT™ and vapor barrier seams.



VAPORMAT™ 080-15

Radon & Moisture Mitigation Channeling System

VAPORMAT™ 080-15 is a 0.9-inch (23.0 mm) thick, highly adaptable matting system used to collect radon, moisture and other toxic vapors coming from the soil around a house and direct them toward an exhaust stack, which leads them safely out through the roof.

It works effectively as part of a passive soil depressurization system (PSD) or a fan can be added to the exhaust stack for an active soil depressurization system (ASD).

Applications

- ✓ Under slab
- ✓ Under membrane
- ✓ In conjunction with gravel or sand
- ✓ Where a pressure field is required across obstacles or distances

Features and Benefits

Reduces Radon, moisture and other toxic vapor levels in the living space of a home

Reduces the potential for mold and mildew problems

Maintains air flow communication across grade beams, downturns, footers and distant corners

Reduces the need for an exhaust fan or basement humidifier reducing lifetime energy costs

Installation is easy saving time and money over other options

Complies with building codes: IRC Appendix F, RRNC 2.0 and ASTM E-1465

Manufactured in USA

Physical Properties

Description	Means of Measurement English/Metric		Value English/Metric	
Core Polymer	Polypropylene			
Thickness	Inches	Mm	0.80	20.0
Geotextile Fabric Weight	oz/yd ²	g/m ²	4.5	153
Protection Fabric Weight	oz/yd ²	g/m ²	1.9	64.0

Packaging

Description	Means of Measurement		Value	
	English/Metric		English/Metric	
Core Width	Inches	CM	15.0	38.1
Length	Feet	Meters	45.0	13.7
Roll Diameter	Inches	CM	20.0	50.8



VAPORMAT™ 040-48

Radon & Moisture Mitigation Channeling System

VAPORMAT™ 040-48 is a 0.5-inch (12.5 mm) thick, highly adaptable matting system used to collect radon, moisture and other toxic vapors coming from the soil around a house and direct them toward an exhaust stack, which leads them safely out through the roof.

It works effectively as part of a passive soil depressurization system (PSD) or a fan can be added to the exhaust stack for an active soil depressurization system (ASD).

Applications

- ✓ Under slab
- ✓ Under membrane
- ✓ In conjunction with gravel or sand
- ✓ Where a pressure field is required across obstacles or distances

Features and Benefits

Reduces Radon, moisture and other toxic vapor levels in the living space of a home

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Reduces the need for an exhaust fan or basement humidifier reducing lifetime energy costs

Installation is easy saving time and money over other options

Complies with building codes: IRC Appendix F, RRNC 2.0 and ASTM E-1465

Manufactured in USA

Physical Properties

Description	Means of Measurement English/Metric		Value English/Metric	
Core Polymer	Polypropylene			
Thickness	Inches	Mm	0.40	10.0
Total Weight	oz/yd ²	g/m ²	22.4	759
Core Weight	oz/yd ²	g/m ²	16.0	543
Geotextile Fabric Weight	oz/yd ²	g/m ²	4.5	153
Protection Fabric Weight	oz/yd ²	g/m ²	1.9	64.0

Packaging

Description	Means of Measurement English/Metric		Value English/Metric	
Core Width	Inches	CM	48.0	122
Length	Feet	Meters	50.0	15.24
Area	Square Feet	Square Meters	200	18.6
Roll Diameter	Pounds	Kg	31.0	14.0

Radon System Stabilizer



Introducing the

Radon-T

Radon system stabilizer for RRNC and Radon Systems from RadonAway, the world's leading radon fan manufacturer.

The right fitting to do the right job.

Specifically engineered as the starting point for new construction and crawlspace radon systems.

Designed to help meet ENERGY STAR® IAP, NAHB, LEED-H and other RRNC and Green Building requirements.

Allows moisture and soil gases to be drawn from under the slab from all angles.

Stands flat and can be staked in place to avoid shaky or crooked pipes.

Eliminates the problem of blocked PVC tees that can hinder soil gas and vapor flow.

Watch a Radon-T installation video at www.RadonAway.com/radon-t



4-Way Airflow with Side Knockouts



New Construction Installation



Easily Saddles Over Drainage Piping



Crawlspace Installation



RadonAway.com/radon-t
800-767-3703

Features

The Radon-T

- **Easily Saddles** over drainage piping
- **Works with** aggregate or geotextile matting
- **Provides 4-way air flow** with side knockouts
- **Accepts 4" schedule 40** into socket
- **Ideal** for new construction and crawlspace mitigations

The Radon-T Kit includes

- **Radon-T** To prepare for installation of an active or passive radon, soil gas and moisture control system.
- **4 Stakes** To stabilize the T in preparation for aggregate fill and slab pour.
- **Vent Pipe Cap** To prevent debris entry and, because it is clearly labeled, avoid the possibility of mistaking the vent pipe stub for a utility pipe "rough in".
- **Instruction Guide** Providing installation and use instructions for Radon-T as well as full RRNC system installation instructions (to assist compliance with ANSI/AARST CCAH-2013, ASTM E1465, IRC Appendix F, and state and local codes where applicable).
- **Set of 4 Labels** To clearly mark Radon/RRNC vent pipes.



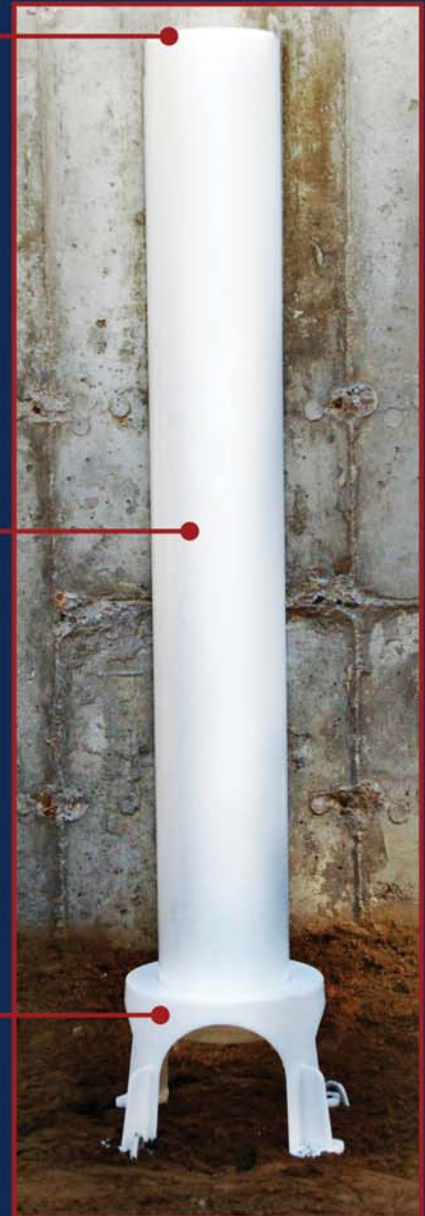
Cap



Pipe provided by builder or installer



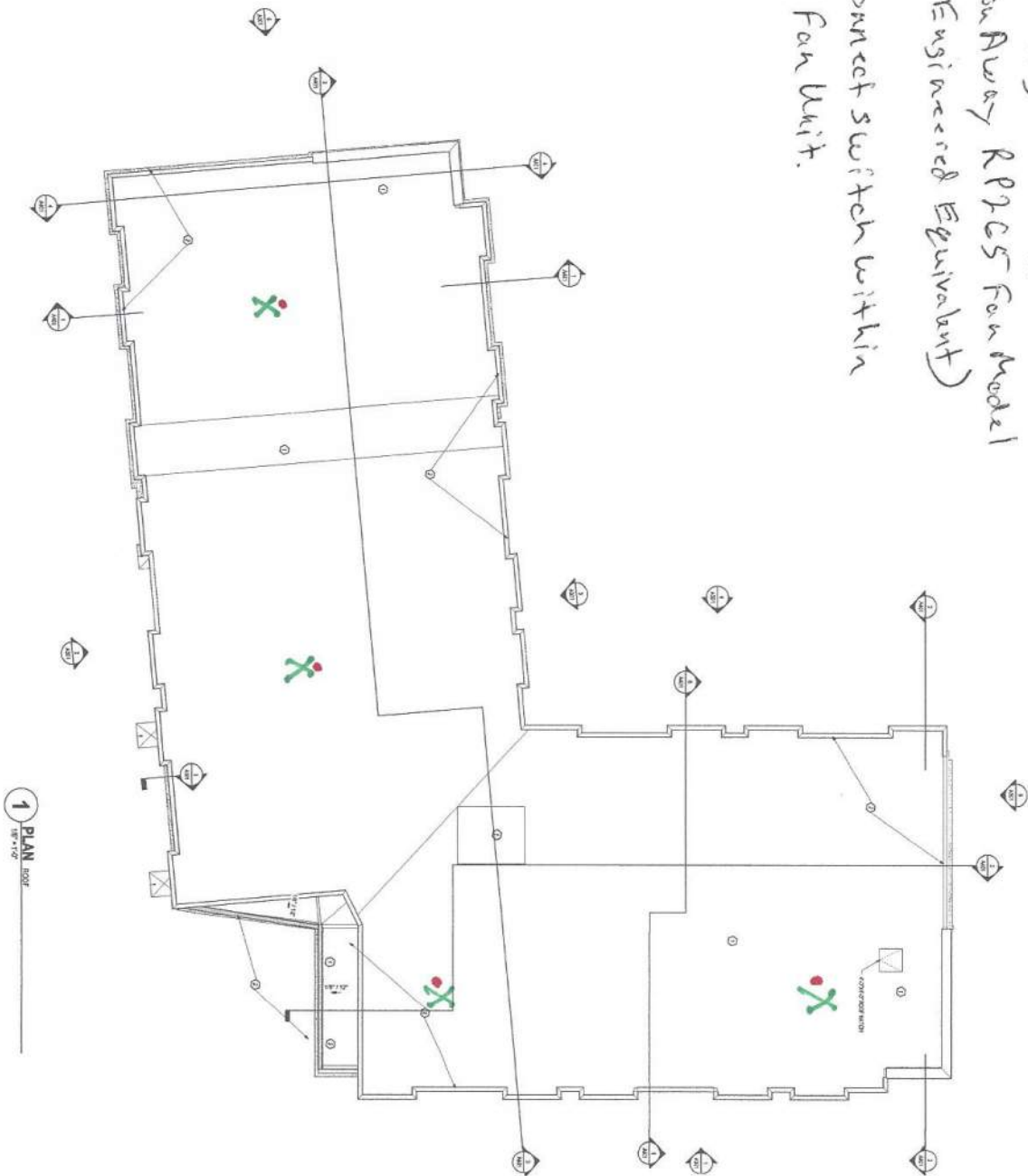
Radon-T



RadonAway.com/radon-t

800-767-3703

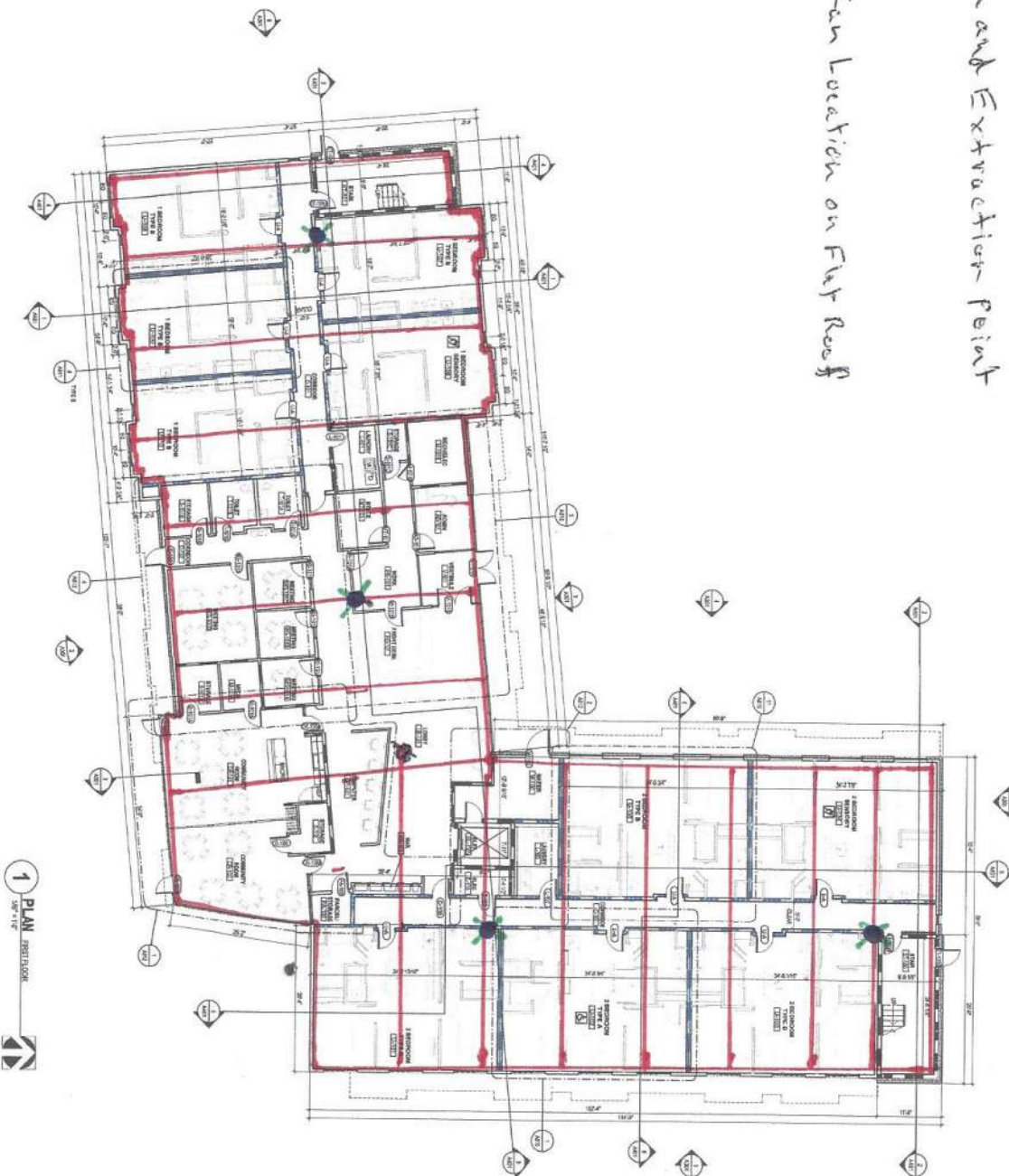
- X Potential and proposed Fan location and venting terminus.
 (Radon Away RPPCS Fan Model or Engineered Equivalent)
- Disconnect switch within 6' of Fan Unit.



1 PLAN ROOF
 1/8" = 1'-0"

PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	DATE: 04/07/2022 DRAWN BY: 42254 CHECKED BY: 42254 PROJECT NO: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254	PROJECT: 42254 OWNER: 42254 CONTRACTOR: 42254

- Proposed Sch. 40 4" PVC Vent Riser Location and Extraction Point Location.
- ✗ * Proposed Fan Location on Flat Roof



1 PLAN FIRST FLOOR
3/8" = 1'-0"

[illegible]

2

1

[illegible][illegible]

DATE	CHARGE DESCRIPTION



HARRIET'S HOPE
 1416 W. 46th Street
 Chicago, IL 60641
 Tel: 773.327.7777
 Fax: 773.327.7778



CHICAGO HOUSING DEPARTMENT
 1000 N. Dearborn Street
 Chicago, IL 60610
 Tel: 773.327.7777
 Fax: 773.327.7778



CHICAGO HOUSING DEPARTMENT
 1000 N. Dearborn Street
 Chicago, IL 60610
 Tel: 773.327.7777
 Fax: 773.327.7778

COPIES OF THIS REPORT	1
DATE OF ISSUE	10/20/2013
PROJECT	PROGRESS DRAWING NOT FOR CONSTRUCTION
PROJECT #/JOB #	A101
REVIEW SET	

SECTION 31 22 13

ROUGH GRADING

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Remove topsoil and stockpile for later reuse.
- B. Excavate subsoil and stockpile for later reuse.
- C. Grade and rough contour site to elevations indicated on Drawings.

1.02 RELATED WORK

- A. Section 31 23 00, "Excavation and Fill"
- B. Section 31 23 33, "Piped Utilities - Basic Methods"
- C. Section 31 24 01, "Backfilling"
- D. Section 31 25 00, "Erosion Control"

1.03 PROJECT RECORD DOCUMENTS

- A. Accurately record location of utilities remaining rerouted utilities, new utilities by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 PROTECTION

- A. Protect trees, shrubs, lawns, and other features remaining as portion of final landscaping.
- B. Protect bench marks, existing structures, roads, sidewalks and paving and curbs.
- C. Protect above or below grade utilities which are to remain.
- D. Repair damage.
- E. Dewatering: All excavation, construction, and backfill of pipes or other facilities to be constructed under this Contract shall be constructed under dry conditions. The Contractor shall constantly maintain all excavations in a dewatered, workable condition, and shall be responsible for installing, operating, maintaining, and removing such dewatering systems as are required. The evaluation of the sufficiency of the condition shall be made by the Architect/Engineer and his/her decision shall be binding upon the Contractor. If the Architect/Engineer determines that dewatering is inadequate, the Contractor shall modify his/her methods until such time as the Architect/Engineer then agrees with the adequacy of the operating condition.

1.05 DEFINITIONS - The following govern earthwork materials, conditions, and operations.

- A. Stripping: Removal of existing surficial unsuitable materials (see definition) to their entire depth or as directed.

- B. Excavation: Cutting, digging, removing, and wasting materials of every description, including soils, foundations, rock, and whatever substance encountered to dimensions, limits, elevations and contours as indicated or required by the Drawings of these Specifications.
- C. Rock: Boulders and detached stones having a volume of 2/3 cubic yards or more and any large masses of igneous, metamorphic, or sedimentary rocks, including firmly conglomerated deposits that cannot be removed with a one cubic yard capacity power shovel without drilling or blasting.
- D. Rock: Dolomite, granite, trap, quartzite, limestone, hard sandstone, slate, or other hard materials, in natural ledges 6 inches or more in thickness, or displaced masses not practical to excavate and remove by use of: (A) dozer or dozer ripper with less than 250 H.P.; (B) backhoe or shovel with bucket capacity of less than 1.5 C.Y.; (C) nonpower operated hand tools. Removal requires line drilling, blasting, pre-splitting, rock wedging, jackhammering, hydro-hammering, and/or the use of other power tools. A ledge shall be considered to be a continuous deposit of any one of the above materials which may or may not include interbedded seams of soft material that can be measured for thickness either horizontally or vertically. If vertical thickness of soft material between layers is less than 12 inches, then this material shall be included and measured as rock excavation. If the horizontal thickness of soft material between rock pinnacles measures less than 30 inches, then this material shall be included and measured as rock excavation.
- E. Unsuitable Materials: Topsoil, loam, gumbo, mud, muck, silt, expansive clay, peat, high organic content soils, rubbish, debris, foundation and slab materials, paving materials, rock greater than 3 inches in diameter, vegetation and frozen or dry lumps. Expansive clay is any clay with an expansion potential in excess at 2%.
- F. Unstable Materials: Materials which are not classified as unsuitable materials, but due to their condition of being wet, dry, or frozen are unacceptable for use in fills.
- G. Imported Fill Material or Borrow: Approved soil materials from sources other than those made available by required excavation of project. Unless specifically provided, no imported fill shall be obtained within limits of project site.
- H. Filling/Backfilling: Placing of approved soil materials in accordance with specified procedures and materials and in conformity with lines, grades, contours, cross-sections, and elevations shown on Drawings or required by these Specifications.
- I. Subgrade: Undisturbed soil or compacted fill material upon which additional fill stabilized subgrade, sub-base or base course, footing, foundation, or slab cushion is placed.

1.06 QUALIFICATION TESTS

- A. Unless otherwise specified, arrange, supervise, and pay for the following required qualification tests.
- B. Soils Materials: Provide the following information and qualifications tests for each required soils material, including select on-site materials, prior to use on project site.
 - 1. Location of sources for each required imported materials prior to delivery to site.
 - 2. Mechanical analysis, ASTM D422.
 - 3. Liquid limit, ASTM D423 - cohesive materials only.

4. Plastic limit and plasticity index, ASTM 424 - cohesive materials only.
5. Proctor density or relative density information according to test method identified in compaction requirements schedule.

1.07 SUBMITTALS

- A. Comply with requirements of Division 0 and 1. Unless noted otherwise, submit two (2) copies of the following items:
 1. Submit material qualification tests and field density test reports directly from testing laboratory.
 2. Submit Soils Engineers Certificate of Inspection and Compliance with specified bearing capacity for all footing/foundation subgrades, acceptability of fill area subgrade, and acceptability of select on-site fill materials, if specified for use.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: Excavated material, graded free of roots, rocks larger than 1 inch, subsoil, debris, and large weeds.

PART 3 EXECUTION

3.01 GENERAL

- A. The following Specification shall be considered as general criteria for earthwork operations. In those instances where field conditions arise which are not adequately covered by these criteria, instructions for that specific condition will be issued by the Architect/Engineer.
- B. Dust Control:
 1. Use all means necessary to control dust on and near the work and on and near all off-site borrow areas if such dust is caused by the Contractor's operations during performance of the work or if resulting from the condition in which the Contractor leaves the site.
 2. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site.
- C. Grading operations shall be performed in such a manner as to direct and control storm water runoff so that no damage or erosion occurs. Saturation of cut and fill areas shall be prevented by directing storm water runoff and not allowing ponding to occur. Fills are to be crowned as required to maintain drainage at the end of each workday. Existing drainage routes shall not be choked or obstructed until new ones are available. Temporary culverts, pumps or other equipment shall be used to facilitate drainage of fills during construction, failure to drain storm water shall not be grounds for delay of this Contract due to saturated site conditions. The Contractor shall remove and dispose of saturated materials in excess of allowable moisture content at compaction and shall maintain the project schedule at all times.

3.02 ROUGH GRADING AND EMBANKMENT CONSTRUCTION

A. Rough Grading:

1. Site clearing and grubbing shall be done prior to any rough grading. All debris and deleterious materials shall be removed from areas to be filled or backfilled.
2. Dispose of excess excavated material or supply additional suitable material as necessary to complete the rough grading to the required elevations.
3. The finished subgrade surface shall be reasonably smooth and free from irregular surface changes and shall be no more than one tenth (0.1) of a foot above or below the approved subgrade elevation.
4. Newly graded areas shall be protected from the action of the elements. Any damage that may occur as a result of natural causes or any construction activities, prior to the acceptance of the work, shall be repaired and grades re-established to the required elevations and slopes.
5. During the performance of rough grading operations, the subgrade shall be examined critically; and any areas discovered which are soft and unstable or exhibit other unusual conditions, shall be immediately pointed out to the Architect/Engineer. Upon the direction of the Architect/Engineer, these areas shall be excavated to such depths as may be necessary to insure satisfactory supporting properties. These areas of excavation shall be backfilled immediately and shall be brought to the elevation of the surrounding area with unsuitable material in accordance with the embankment construction procedure.
6. In general, subgrade shall be established at the following levels:
 - a. For Pavement Areas: Finish grade less the thickness of pavement and base material.
 - b. For Structures: Finish floor elevations less the thickness of the slab and any porous fill.
 - c. For Lawn Areas: 4 inches below finished grade.

B. Compaction and Proof Rolling of Subgrade:

1. All subgrade surfaces shall be proof rolled by means of heavy equipment to locate and permit timely correction of the subgrade deficiencies.
2. In cut sections, proof rolling of the subgrade surface shall be done to determine the location and extent of areas below subgrade surface that may require subgrade undercutting. Should any portion of the cut subgrade surface fail to provide satisfactory support for the proof rolling operation, the Architect/Engineer may order corrective undercut and backfill work done.
3. In embankment Sections, prior to placing the embankment, proof rolling on the subgrade surface shall be done to determine the uniformity of the compaction below the subgrade and any deficiencies requiring corrective work. Any deficiencies discovered during proof rolling operations shall be corrected in a manner satisfactory to the Architect/Engineer. After all corrective work has been completed, the surface shall be proof rolled again. Corrective work shall not be considered complete and acceptable until the embankment shows satisfactory and uniform response to the proof rolling operations.

C. Embankment:

1. After clearing, grubbing, and proof rolling of the existing subgrade has been completed, the surface of the area to be filled shall be scarified to a depth of 4 to 6 inches. An initial 3 inch layer of fill material shall then be spread over the scarified surface and the entire area compacted as specified below.
2. Each layer of fill material shall be compacted until its density is not less than 95% of the maximum density as determined by the moisture content relationship test ASTM D-698.

3. Areas requiring fill shall be filled and backfilled using suitable materials compacted in layers not to exceed the following (all thicknesses are loose thicknesses):
 - a. Within building or structure areas - 8 inches.
 - b. Under pavements - 12 inches.
 - c. Under planted areas - 12 inches.
4. The moisture content of placed material shall not deviate from the optimum by more than $\pm 3\%$. Moisture content of any material which displays pronounced deformation under construction equipment shall not exceed the optimum. Drying of wet soil shall be expected by the use of plows, discs, harrows, or other approved methods. If additional water is required, it should be uniformly distributed through the use of approved water wagons and shall be thoroughly incorporated into the material by means of discs or other suitable mixing equipment. Care shall be taken to avoid trapping water within the fill.
5. The embankment and borrow areas should be maintained in a freely draining condition at all times. Proper drainage should be provided for any water or springs which may be encountered.
6. When the embankment meets the natural grade of a slope, a bench shall be cut in the existing slope. These cuts are to serve as keys to connect the existing grade with the newly placed fill.
7. Frozen fill material nor any suitable fill shall not be placed on frozen or snow-covered surfaces.
8. If soft, yielding material is encountered in embankments as a result of trapping water, and cannot be satisfactorily stabilized by moisture control and compaction, the unstable material shall be excavated to the depth required by the Architect/Engineer. The excavation shall then be filled with suitable material and compacted in accordance with the requirements outlined above.

3.03 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Identify known below grade utilities. Stake and flag locations.
- C. Identify and flag above grade utilities.
- D. Maintain and protect existing utilities remaining which pass-through work area.
- E. Notify utility company to remove and relocate utilities.
- F. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Construction Manager and Architect/Engineer.

3.04 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded and stockpile in area designated on site.
- B. Do not excavate wet topsoil.

3.05 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be re-landscaped or re-graded and stockpile in area designated on site. Excess subsoil is to be placed on site as directed by the Architect.
- B. Do not excavate wet subsoil.

3.06 TOLERANCES

- A. Top of Surface of Subgrade: Plus, or minus 1 inch.

END OF SECTION

SECTION 31 23 33

PIPED UTILITIES-BASIC METHODS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Excavate trenches for utilities from 5 feet outside building to municipal utilities or as shown on Drawings.
- B. Compacted bedding for utilities.
- C. Backfilling and compaction.

1.02 RELATED SECTIONS

- A. Section 01 40 00, "Quality Requirements"
- B. Section 31 00 00, "Earthwork"
- C. Section 33 11 00, "Water Distribution"
- D. Section 33 51 00, "Natural Gas Distribution"
- E. Section 33 40 00, "Storm Drainage"
- F. Section 33 30 00, "Sanitary Sewerage"
- G. Section 03 30 00, "Cast-in-Place Concrete"

1.03 REFERENCES

- A. ANSI/ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.
- B. ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb. (2.49 kg) Rammer and 12 inch (304.8 mm) Drop.
- C. ANSI/ASTM D1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
- D. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil - Aggregate Mixtures using 10 lb. (4.54 kg.) Rammer and 18 inch (457 mm) Drop.
- E. ANSI/ASTM D2922 - Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
- F. ANSI/ASTM D3017 - Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.04 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Samples: Submit 10 lb. sample to laboratory, in air-tight containers.
- C. Samples shall be submitted to the Testing Agency one (1) week prior to fill placement, in order to complete qualification tests.

1.05 FIELD MEASUREMENTS

- A. Verify that survey benchmark and intended elevations for the Work are as shown on Drawings.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Type A, D, J or K materials as specified in Section 31 00 00, "Earthwork."

2.02 BED MATERIALS

- A. Type B Materials: As specified in Type B in Section 31 00 00, "Earthwork."
- B. Type C Material: As specified for Type C in Section 31 00 00, "Earthwork."
- C. Type E Material: As specified for Type E in Section 31 00 00, "Earthwork."
- D. Concrete: Structural concrete conforming to Cast-In-Place Concrete Section with a compressive strength of 1500 psi.

2.03 ACCESSORIES

- A. Geotextile Fabric: Mirafi Geotextile, 160 N or equal for use with underdrain.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify fill materials to be used are acceptable.

3.02 PROTECTION OF PERSONS AND PROPERTY

- A. The Engineer has designed a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job site safety during construction, which are exclusively the Contractor's responsibility. Processing and/or approving submittals made by the Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed, shall not be construed as voluntary assumption by the Engineer of any responsibility for safety procedures.

- B. Earthwork:
 - 1. Stability of temporary excavations:
 - a. All excavations shall be in accordance with OSHA requirements.
 - b. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
 - c. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
 - 2. Shoring:
 - a. Except as specified elsewhere, provide all shoring required for earthwork or required as a result of earthwork for safety of workers, existing structures, public or adjacent properties.
 - b. Provide materials for shoring and bracing in good serviceable condition.
 - c. Establish requirements for shoring and bracing to comply with local codes and authorities having jurisdiction.
 - d. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

3.03 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Maintain and protect existing utilities remaining, which pass through work area. Repair damaged utilities to the satisfaction of the Owner of the utility and the Associate Engineer.
- C. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- D. Protect benchmarks, existing structures, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.
- E. Protect above and below grade utilities which are to remain.

3.04 EXCAVATION

- A. Excavate subsoil and whatever material encountered including rock, required for storm sewers, sanitary sewers, water and gas piping. See rock definition in Earthwork Section.
- B. Cut trenches sufficiently wide to enable installation of utilities and allow inspection and as shown on details provided on Drawings.
- C. Excavations shall not interfere with normal 45 degree bearing splay of foundations.
- D. Hand trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- E. Remove lumped subsoil, boulders, and rock greater than 1/3 cu. yd. measured by volume.
- F. Correct unauthorized excavation at no cost to Owner.
- G. Correct areas over-excavated by error in accordance with Earthwork Section at no cost to Owner.

- H. Stockpile excavated material in area designated on site and remove excess material not being used, from site.
- I. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with Type D fill and compact to density equal to or greater than requirements for subsequent backfill materials. Corrective undercut and backfill will be paid for per Earthwork Section, Paragraph 3.04, A.5.
- J. Dewatering: All excavation, construction and backfill of pipes or other facilities to be constructed under this Contract shall be constructed under dry conditions. The Contractor shall constantly maintain all excavations in a dewatered, workable condition, and shall be responsible for installing, operating, maintaining and removing such dewatering systems as are required. The evaluation of the sufficiency of the condition shall be made by the Associate Engineer and his/her decision shall be binding upon the Contractor. If the Associate/Engineer determines that dewatering is inadequate, the Contractor shall modify his/her methods until such time as the Associate Engineer then agrees with the adequacy of the operating condition.

3.05 BEDDING

- A. Support pipe and conduit during placement and compaction of bedding fill.
- B. Bed per Standard Details provided on Drawings and Schedule at the end of this Section.

3.06 BACKFILLING

- A. Backfill trenches to contours and elevations with unfrozen materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Granular Fill: Place and compact materials in continuous layers not exceeding 8 inches compacted depth.
- D. Soil Fill: Place and compact material in continuous layers not exceeding 8 inches compacted depth.
- E. Employ a placement method that does not disturb or damage conduit in trench.
- F. Maintain optimum moisture content of backfill materials to attain required compaction density.
- G. Leave fill material stockpile areas completely free of excess fill materials.

3.07 TOLERANCES

- A. Top Surface of Backfilling: Under Paved Areas: Plus, or minus 1 inch from required elevations.
- B. Top Surface of General Backfilling: Plus, or minus 1 inch from required elevations.

3.08 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Tests and analysis of fill material will be performed in accordance with ANSI/ASTM D698 and with Division 1.
- C. Compaction testing will be performed in accordance with ASTM D2922 and ASTM D3017 and with Division 1.
- D. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest at no cost to Owner.
- E. Frequency of Tests: Every two lifts.

3.09 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Division 1.
- B. Recompect fills subjected to vehicular traffic.

3.10 SCHEDULE

- A. Storm and Sanitary Piping:
 - 1. Bedding Fill: Type E, per Standard Detail, compacted to 95%.
 - 2. Cover with Type D in 8 inch lifts, compacted to 95%.
 - 3. Under roadways, parking lots, sidewalks and plaza areas, backfill with Type D in 8 inch lifts compacted to 98%.
 - 4. Under roadways, parking lots, sidewalks, and plaza areas where cover from top of subgrade to top of pipe is less than 48 inches, backfill with Type A or Type J in 8 inch lifts, compacted to 98%.
 - 5. Under roadways, parking lots, sidewalks, and plaza areas where cover from top of subgrade to top of pipe is 30 inches or less, provide reinforced concrete pipe or concrete encasement per Standard Detail.
- B. Waterlines:
 - 1. Bedding Fill: Type A under roadways, parking lots, sidewalks, and plaza areas. Type D in lawn areas.
 - 2. Cover with Type D in 8 inch lifts, compacted to 95%.
 - 3. Under roadways, parking lots, sidewalks and plaza areas, backfill with Type A or Type J in 8 inch lifts, compacted to 100%.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Temporary and permanent erosion and sediment control.
- B. Comply with OEPA requirements and Stormwater Pollution Prevention Plan prepared for this project.

1.02 RELATED WORK

- A. Section 31 00 00, "Earthwork"
- B. Section 32 92 00, "Turfs and Grasses"

1.03 SUBMITTALS

- A. Comply with requirements of Division 0 and 1. Submit material qualification tests and certificates of compliance as indicated.
- B. In accordance with the Stormwater Pollution Prevention Plan (SWPPP) prepared for the project, all stormwater BMPs shall be inspected once every seven (7) days and within 24 hours of a 0.5 inch or greater rainfall. Inspection logs (included herein) shall be kept and shall be submitted to the Owner or Ohio EPA upon request.
- C. At project completion (when all seeding and landscaping is well established), Contractor shall complete and submit to the Ohio EPA the included Notice of Termination (NOT) to terminate coverage from the NPDES General Permit. A copy of the NOT and transmittal shall be provided to the Owner and the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: Type F Material - Section 31 00 00, "Earthwork."
- B. Filter Barrier Geotextile: The geotextile shall be of either woven or nonwoven construction and consist of long chain polymeric filaments or fibers composed of polypropylene, polyethylene or polyimide. The filament and fibers shall be oriented into a stable network whereby they retain their positions relative with each other. The geotextile shall be ultraviolet stabilized and shall be inert to chemicals commonly found in soil. The geotextile shall meet or exceed physical properties of Supac 5NPUV or Supac G WMUV.
 - 1. Grab Tensile Strength: 90 lb. minimum as measured per test method ASTM D 1682.
 - 2. Mullen Burst Strength: 190 psi minimum as measured per test method ASTM D 3786.
 - 3. Slurry Flow Rate: 0.3 gal./min./ft² maximum.
 - 4. Equivalent Opening Size: 40-80 as measured per test method US Std. Sieve CW-02215.
 - 5. Ultraviolet Radiation Stability: 70% minimum as measured per test method ASTM D 4355.

- C. Filter Barrier Stakes: 2" x 2" x 3'-0" wooden stakes.
- D. Rock Channel Protection: Quarried stone meeting the requirements of ODOT Item 601.09 Rock Channel Protection, Type A, B, C, or D with filter, as noted on Drawings.
- E. Seed and Soil Supplements for Temporary Seeding: Provide seed mixture with 20% by weight of perennial ryegrass, 30% red fescue and 50% Kentucky Blue Grass. Provide pulverized agricultural limestone and commercial fertilizer, 10-20-20 or approved substitute.
- F. Mulch: Unrotted straw free from weeds and course material or other approved product suitable for required application.
- G. Mulch Binder: Cutback or emulsified asphalt or synthetic binder such as Petroset, Terratack or Aerospray.
- H. Jute Matting: Cloth or Plain weave, undyed and unbleached single jute yarn, 47 to 49 inches wide, averaging 1.15 to 1.26 lbs., per lin. yard loosely twisted construction of not less than 1.6 turns per inch, 78 warp ends per width of cloth and 41 weft ends per lin. yard, meeting the requirements of CC Item 671.
- I. Matting Staples; No. 8 plain wire, 6-10 inches long.
- J. Commercial Matting Products: Erosionet, Holdgro, Weedcheck, Curlex or approved equal. Product must cover minimum of 30% of soil surface and meeting the requirements of CC Item 671.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide temporary and permanent erosion and sediment control items as required by governing agency, as required by permit, as indicated on the plans, as noted in this Specification, and as noted in the Stormwater Pollution Prevention Plan.

3.02 INSTALLATION

- A. Install temporary erosion and sediment control items prior to clearing and commencing earthwork or as soon as practical as sitework progresses.
- B. Install required permanent erosion and sediment control items as soon as no damage or deterioration will result to those items due to construction activities.

3.03 TEMPORARY ACCESS ROAD AND CONTRACTOR USE AREA

- A. Locate access road where indicated or as approved by Owner and local authority having jurisdiction over public roads in vicinity of site. Locate use areas where indicated or as convenient.
- B. Access road shall be at least 20 feet wide. All cuts and fill shall be 3:1 or flatter to the extent possible. Drainage ditches shall be provided as needed. The roadbed and use areas surface shall be cleared of all vegetation, roots, and other objectionable material.

- C. The entrance shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with stone, as conditions demand, and repair and/or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately.
- D. All roadside ditches, cuts, fills and disturbed areas adjacent to use areas and access road shall be stabilized with appropriate temporary vegetation immediately after grading.
- E. Both road and use areas may require periodic top dressing with new stone. Seeded areas should be checked periodically to ensure that a vigorous stand of vegetation is maintained. Ditches and other drainage structures should be checked regularly to ensure that they do not become clogged with silt or other debris.

3.04 FILTER FABRIC BARRIERS

- A. Construct where indicated or otherwise required by grading operations to reduce sediment content or runoff.
- B. The height of a filter barrier shall be a minimum of 15 inches and shall not exceed 18 inches.
- C. Filter barrier geotextile shall be purchased in a continuous roll and cut to the length of the barrier to avoid the use of joints.
- D. The stakes shall be spaced a maximum of 3 feet apart at the barrier location and driven securely into the ground (minimum of 8 inches).
- E. A trench shall be excavated approximately 4 inches wide and 4 inches deep along the line of stakes and upslope from the barrier.
- F. The filter material shall be stapled to the wooden stakes, and 8 inches of the fabric shall be extended into the trench. Heavy duty wire staples at least 1/2 inch long shall be used. Filter materials shall not be stapled to existing trees.
- G. The trench shall be backfilled, and the soil compacted over the filter material.
- H. If a filter is to be constructed across a ditch line or swale, the barrier shall be of sufficient length to eliminate end flow, and the plan configuration shall resemble an arc or horseshoe with the ends-oriented upslope.
- I. Filter barrier shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.
- J. Filter barrier shall be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs shall be made immediately.
- K. Should the fabric on the filter barrier become ineffective prior to the end of its need, the fabric shall be replaced promptly.
- L. Sediment deposits should be removed after each rainfall. They shall be removed when deposits reach approximately one-half the height of the barrier.

- M. Any sediment deposits remaining in place after the silt fence or filter barrier is no longer required shall be dressed to conform with the existing grade, prepared, and seeded.

3.05 ROCK CHANNEL PROTECTION (RCP) PLACEMENT

- A. Place RCP on bedding layer, where indicated, to produce a well graded mass of rock with minimum practical percentage of voids.

3.06 TOPSOIL STORAGE AND APPLICATION

- A. Stockpile acceptable topsoil generally where indicated and in such a manner that natural drainage is not obstructed, and no off-site sediment damage shall result. Side slopes of the stockpile shall not exceed 2:1.
- B. A perimeter dike with gravel outlet, silt fence, or straw bale barrier shall surround all topsoil stockpiles.
- C. Temporary seeding of stockpiles shall be completed within seven (7) days of the formation of the stockpile.
- D. Before topsoiling, establish indicated and needed erosion and sediment control items such as diversions, berms, dikes, waterways, sediment basin, etc. Previously established grades on the areas to be topsoiled shall be maintained according to the Drawings.
- E. After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 2 inches to insure bonding of the topsoil and subsoil.
- F. Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed sodding or seeding. The topsoil shall be uniformly distributed to a minimum compacted depth of 3 inches on 3:1 or steeper slopes and 4 inches on flatter slopes. Any irregularities in the surface, resulting from topsoiling or other operations, shall be corrected in order to prevent the formation of depressions or water pockets. Avoid undue compaction.

3.07 TEMPORARY FILL DIVERSION

- A. The diversion shall be constructed at the top of the fill at the end of each workday as needed.
- B. The diversion shall be located at least 2 feet inside the top edge of the fill.
- C. The supporting ridge of the lower side shall be constructed with a uniform height along its entire length.
- D. Since the practice is temporary and under most situations will be covered the next workday, the maintenance required should be low. If the practice is to remain in use for more than one day, an inspection will be made at the end of each workday and repairs made to the measure if needed. The Contractor should avoid the placement of any material over the structure while it is in use. Construction traffic should not be permitted to cross the diversion.

3.08 TEMPORARY DIVERSION DIKE

- A. Whenever feasible, the dike should be built before construction begins on the project.
- B. The dike should be adequately compacted to prevent failure.
- C. Temporary or permanent seeding and mulch shall be applied to the dike within fifteen (15) days of construction.
- D. The dike should be located to minimize damages by construction operations and traffic.
- E. The measure shall be inspected after every storm and repairs made to the dike, flow channel, and outlet, as necessary. Approximately once every week, whether a storm has occurred or not, the measure shall be inspected, and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

3.09 SEEDING

- A. Incorporate lime and 10-20-20 fertilizer into soil prior to seeding. Apply lime at 900 lbs./1000 S.Y. Apply fertilizer at 200 lbs./1000 S.Y. Apply seed at 25 lbs./1000 S.Y. Within 48 hours after any given area is seeded, straw or hay shall be evenly placed over all seeded areas at the rate of approximately 2 tons per acre for straw, or 3 tons per acre for hay, when seeding is performed between the dates of March 15 and October 15, and the approximate rate of 3 tons per acre straw, or 4 1/2 tons per acre for hay, when seeding is performed between the dates of October 15 and March 15 of the succeeding year. Provide matting where required to establish seed growth.
- B. Areas which fail to establish vegetative cover adequate to prevent rill erosion will be re-seeded as soon as such areas are identified.

3.10 MAINTENANCE

- A. Maintain all erosion and sediment control items until final project acceptance. Repair breaches and replace deteriorated or missing items immediately after discovery.
- B. In accordance with the Stormwater Pollution Plan (SWPPP) prepared for the project, all stormwater BMPs shall be inspected once every seven (7) days and within 24 hours of a 0.5 inch or greater rainfall. Inspection logs (included herein) shall be kept and shall be submitted to the Owner or Ohio EPA upon request.
- C. Clean sedimentation basins and catch basins as required to maintain effectiveness or as otherwise directed.
- D. Removal: Remove temporary erosion control items as directed and prior to Project close-out.

END OF SECTION

CONSTRUCTION POLLUTION PREVENTION PLAN

SITE DESCRIPTION			
Project Name and Location: (Latitude, Longitude, or Address)	Latitude: Longitude:	Owner Name and Address:	
Description: (Purpose and Types of Soil Disturbing Activities)	This project consists of _____.		
Soil disturbing activities will include: • Clearing and grubbing • Installing stabilized construction entrance • Perimeter and other erosion and sediment controls • Grading including detention ponds • Storm sewers including detention pond outlet with temporary sediment controls • Construction roads, buildings, etc. • Final preparation including plantings and seeding			
Runoff Coefficient:	The final coefficient for the area of the site will be C = _____. The existing coefficient is C = _____.		
Site Area:	The site is approximately ____ acres of which approximately ____ acres will be disturbed by construction.		
Sequence of Major Activities (Unless otherwise noted, all activities are the responsibility of the General Contractor.)			
1. Install stabilized construction entrance. 2. Install perimeter erosion control measures where required. 3. Clear and grub. 4. Strip and stock pile topsoil. Seed stock piles. 5. Begin rough grading. 6. Construct detention/sediment basins with outlet protection. 7. Complete rough grading.		8. Install storm sewers and bale inlet filters. 9. Install pavement aggregate base. 10. Construct curb, islands and walks. 11. Complete final paving. 12. Complete fine grading of seeded areas and install permanent seeding and mulching. 13. Remove temporary erosion control measures. Clean sediment from detention basins.	
Name of Receiving Waters:	The area tributary to the site flows into _____ which eventually flows to _____.		

CONTROLS	
Erosion and Sediment Controls	
Stabilization Practices	
<u>Area requiring temporary stabilization</u> Any disturbed areas within 50 feet of a stream and not at final grade. For all construction activities, any disturbed areas that will be Dormant for more than 21 days but less than one year, and not Within 50 feet of a stream. Disturbed areas that will be idle over winter.	<u>Time frame to apply erosion controls</u> Within two days of the most recent disturbance if the area will Remain idle for more than 21 days. Within seven days of the most recent disturbance within the area. Prior to the onset of winter weather.
<u>Temporary Stabilization</u> – Topsoil stock piles will be stabilized with temporary seed and mulch no later than 7 days from the last construction activity in that area. Temporary stabilization must also be applied to any area which will lie idle over the winter. The temporary seed shall be Rye (grass) applied at a rate of 25 lbs. per 1000 S.Y. Prior to seeding, 900 pounds of ground agricultural limestone and 200 pounds of 10-20-20 fertilizer shall be applied to every 1000 S.Y. stabilized. Within 48 hours after any given area is seeded, straw or hay shall be evenly placed over all seeded areas at the rate of approximately 2 tons per acre for straw, or 3 tons per acre straw, or 4-1/2 tons per acre for hay, when seeding is performed between the dates of October 15 and March 15 of the succeeding year. Acres to be paved will be temporarily stabilized by applying stone subbase until bituminous pavement can be applied.	
<u>Area requiring permanent stabilization</u> Any areas that will lie dormant for one year or more. Any areas within 50 feet of a stream and at final grade. Any other areas at final grade.	<u>Time frame to apply erosion controls</u> Within seven days of the most recent disturbance. Within two days of reaching final grade. Within seven days of reaching final grade within that area.
<u>Permanent Stabilization</u> –Permanent seed mix shall consist of 260 lbs/acre of turf Tall Fescue. Prior to seeding, apply commercial fertilizer at the rate of 1 pound actual Nitrogen per 1000 square feet. Fertilizer to have 20:22:14 analysis. After seeding, each area shall be mulched using Turfiber (or equivalent) at a rate of 2000 lbs. per acre with 50 pounds of Turfiber added per 100 gallons of machine capacity. Keep Hydromulch from non-target areas including pavement, plant materials, curbing, and structures. If these surfaces are hit during Hydromulching operations, wash the surface immediately.	
Structural Practices	
Detention Basin: A detention basin will be constructed for this project. It will collect runoff from approximately ____ acres of the project and discharge into _____. The _____ will carry flow to _____.	
Storm Water Management	
When construction is complete, stormwater drainage for the developed areas will be provided by a series of inlets connected by storm sewers that will outlet into the detention basin. Storm water will be released at a controlled rate by the outlet structure. The rate was determined by the Local Authority Having Jurisdiction. The areas disturbed, which are not paved, will be permanently seeded.	
OTHER CONTROLS	
Offsite Vehicle Tracking:	
A stabilized construction entrance will be provided to help reduce vehicle tracking of sediments. The paved road adjacent to the site entrance will be swept daily to remove any excess mud, dirt, or rock tracked from the site. Dump trucks hauling material to or from the construction site will be covered with a tarpaulin.	

TIMING OF CONTROLS/MEASURES
Areas where construction activity temporarily ceases for more than 21 days will be stabilized with a temporary seed and mulch as soon as possible or within 7 days of the last disturbance. Once construction activity ceases permanently in an area, that area will be stabilized within 7 days with permanent seed and mulch. Stripped and stockpiled topsoil should be within 7 days using temporary stabilization seed mix, as described above. After all topsoil has been used the remaining stockpiled topsoil should be seeded using the permanent stabilization method as noted.
CERTIFICATION OF COMPLIANCE WITH FEDERAL, STATE, AND LOCAL REGULATIONS
The storm water pollution prevention plan reflects Federal and State Requirements for storm water management and erosion and sediment control. To ensure compliance, this plan was prepared in accordance with the Storm Water Management for Construction Activities published by the EPA.
MAINTENANCE/INSPECTION PROCEDURES
Erosion and Sediment Control Inspection and Maintenance Practices
These are the inspection and maintenance practices that will be used to maintain erosion and sediment controls. • All control measures will be inspected at least once each week and following any storm event of 0.5 inches or greater. • All measures will be maintained in good working order, if a repair is necessary, it will be initiated within 24 hours of report. • Built up sediment will be removed from silt fence when it has reached one-third of height of fence. • Silt fence will be inspected for depth of sediment tears, to see if fabric is securely attached to the fence posts and to see that the fence post be firmly in the ground. • Temporary and permanent seeding and planting will be inspected for bare spots, washouts, and healthy growth. • A maintenance inspection report will be made after each inspection. • Personnel selected for inspection and maintenance responsibilities will receive training from the Site Superintendent. They will be trained in all inspection and maintenance practices necessary for keeping the erosion and sediment controls used onsite in good working order.
Non-Storm Water Discharges
It is expected that the following non-storm water discharges will occur from the site during the construction period: • Water from water line flushings. • Pavement wash waters (where no spills or leaks of toxic or hazardous materials have occurred). • Uncontaminated groundwater (from dewatering excavation). All dewatering discharges shall be effectively treated prior to release. No turbid discharges are permitted.
INVENTORY FOR POLLUTION PREVENTION PLAN
The materials or substances listed below are expected to be present onsite during construction. • Concrete • Detergents • Paints (enamel and latex) • Metal Studs • Concrete • Tar • Fertilizers • Petroleum Based Products • Cleaning Solvents • Wood • Masonry Block

SPILL PREVENTION	
Material Management Practices	
The following are the material management practices that will be used for reducing the risk of spills or other accidental exposure of materials and substances to storm water runoff.	
Good Housekeeping	The following good housekeeping practices will be followed onsite during the construction project: • An effort will be made to store only enough product required to do the job. • All materials stored onsite will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure. • Products will be kept in their original containers with the original manufacturer's label. • Substances will not be mixed with one another unless recommended by the manufacturer. • Whenever possible, all of a product will be used up before disposing of the container. • Manufacturer's recommendations for proper use and disposal will be followed. • The site superintendent will inspect daily to ensure proper use and disposal of materials onsite.
Hazardous Products:	These practices are used to reduce the risks associated with hazardous materials. • Products will be kept in original containers unless they are not resealable. • Original labels and material safety data will be retained; they contain important product information. If surplus product must be disposed of, manufacturers or local and State recommended methods for proper disposal will be followed.
Product Specific Practices	
The following product specific practices will be followed onsite:	
Petroleum Products:	All onsite vehicles will be monitored for leaks and receive regular preventative maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers, which are clearly labeled. Any asphaltic substances used onsite will be applied according to the manufacturer's recommendations.
Fertilizers:	Fertilizers used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to limit exposure to storm water. Storage will be in a covered shed. The contents of any partially used bags of fertilizers will be transferred to a sealable plastic bin to avoid spills.
Paints:	All containers will be tightly sealed and stored when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to manufacturer's instructions or State and local regulations.

SPILL PREVENTION (Continued)**Spill Control Practices**

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturer's recommended methods of spill cleanup will be clearly posted and site personnel will be aware of the procedures and the location of the information and cleanup supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage area onsite. Equipment and materials will include but not be limited to brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.
- All spills will be cleaned up immediately after discovery.
- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
- Spills of toxic or hazardous material will be reported to the appropriate State or local government agency, regardless of size.
- The spill prevention plan will be adjusted to include measures to prevent this type of spill from reoccurring and how to clean up the spill if there is another one. A description of the spill, what caused it, and the cleanup measures will also be included.

POLLUTION PREVENTION PLAN CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are sufficient penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Owners Representative

Name (Print): _____

Title: _____

Signature: _____

Date: _____

CONTRACTOR'S CERTIFICATION

I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

Signature	For	Responsible for
Date: _____ Print Name: _____		



Construction Site Inspection Checklist

By making use of some simple Best Management Practices (BMPs) a construction site operator can do his or her share to protect Ohio's water resources from the harmful effects of sediment. The topography of the site and the extent of the construction activities will determine which of these practices are applicable to any given site, but the BMPs listed here are applicable to most construction sites. For details on the installation and maintenance of these BMPs, please refer to *2008 Rainwater and Land Development, Ohio's Standards for Storm Water Management Land Development and Urban Stream Protection* by the Ohio Department of Natural Resources (ODNR) Division of Soil and Water Conservation. The manual is available at <http://www.dnr.state.oh.us/tabid/9186/Default.aspx> or by contacting your county Soil and Water Conservation District.

Temporary Stabilization

This is the most effective BMP. All disturbed areas that will lie dormant for over 21 days must be stabilized within 7 days of the date the area becomes inactive. The goal of temporary stabilization is to provide cover, quickly. Areas within 50 feet of a stream must be stabilized within 2 days of inactivity. This is accomplished by seeding with fast-growing grasses then covering with straw mulch. Apply only mulch between November 1 and March 31. To minimize your costs of temporary stabilization, leave natural cover in place for as long as possible. Only disturb areas you intend to work within the next 21 days.

Construction Entrances

Construction entrances are installed to minimize off-site tracking of sediments. A stone access drive should be installed at every point where vehicles enter or exit the site. Every individual lot should also have its own drive once construction on the lot begins.

Sediment Ponds

Sediment ponds are required for construction areas with concentrated runoff, when the design capacity of silt fence or inlet protection is exceeded, or for drainage areas with 10 or more disturbed areas. There are two types of sediment ponds: sediment basins and sediment traps. A sediment trap is appropriate where the contributing drainage area is 10 acres or less. The outlet is an earthen embankment with a simple stone spillway. A sediment basin is appropriate for drainage areas larger than 10 acres. The outlet is an engineered riser pipe. Often a permanent storm water management pond, such as a retention or detention basin, can be modified to act as a sediment basin during construction. All sediment ponds must be installed within 7 days of first grubbing the area they control, provide a minimum dewatering zone of 67 cubic yards per acre of total contributing drainage area and a sediment settling zone of 34 cubic yards per disturbed acre below the level of the outlet. Sediment basins must be designed to drain the dewatering zone over a 48-hour period.

Silt Fence

This is typically used at the perimeter of a disturbed area. It's only for small drainage areas on relatively flat slopes or around small soil storage piles. Not suitable where runoff is concentrated in a ditch, pipe or through streams. For large drainage areas where flow is concentrated, collect runoff in diversion berms or channels and pass it through a sediment pond prior to discharging it from the site. Combination barriers constructed of silt fence supported by straw bales or silt fence embedded within rock check dams may be effective within small channels. As with all sediment controls, silt fence must be capable of pooling runoff so that sediment can settle out of suspension. Silt fence must be installed within 7 days of first grubbing the area it controls.

Inlet Protection

This must be installed on all yard drains and curb drains when these inlets do not drain to a sediment trap or basin. Even if there is a sediment trap or basin, inlet protection is still recommended, as it will increase the overall sediment removal efficiency. These are best used on roads with little or no traffic. If working properly, inlet protection will cause water to pond. If used on curb inlets, streets will flood temporarily during heavy storms. Check with your municipality before installing curb inlet protection. They may prefer an alternate means of sediment control such as silt fence or ponds.

Permanent Stabilization

All areas at final grade must be permanently stabilized within 7 days of reaching final grade. This is usually accomplished by using seed and mulch, but special measures are sometimes required. This is particularly true in drainage ditches or on steep slopes. These measures include the addition of topsoil, erosion control matting, rock rip-rap or retaining walls. Permanent seeding should be done March 1 to May 31 and August 1 to September 30. Dormant seeding can be done from November 20 to March 15. At all other times of the year, the area should be temporarily stabilized until a permanent seeding can be applied.

Non-Sediment Pollution Control

Although sediment is the pollutant of greatest concern on most construction sites, there are other sources of pollution. Most of these BMPs are easy to implement with a little bit of planning and go a long way toward keeping your site clean and organized. Please be sure to inform all contractors how these BMPs affect their operations on the site, particularly those that will be working near a stream.

Inspection Sheet

INSPECTIONS MUST BE CONDUCTED ONCE EVERY 7 DAYS AND WITHIN 24 HOURS OF A 0.5" OR GREATER RAINFALL. ALL SEDIMENT CONTROLS MUST BE INSTALLED PRIOR TO GRADING AND WITHIN 7 DAYS OF FIRST GRUBBING

GENERAL INSPECTION INFORMATION

Construction Site Inspection Date: _____ Inspector Name: _____

Inspector Title: _____ Qualifications/Certifications: _____

Storm Events of the Last 7 Days

Storm Event Date	Storm Event Time	Storm Event Duration	Total Rainfall Amount	Discharge Occur? (Y/N)
_____	_____	_____	_____ (inches)	_____
_____	_____	_____	_____ (inches)	_____
_____	_____	_____	_____ (inches)	_____
_____	_____	_____	_____ (inches)	_____

Weather Information at the Time of Inspection

Temperature _____ Climate (Sunny, Cloudy, Rain)? _____ Is Storm Water Being Discharged? _____

Sketch or Small Site Map

Along with a narrative inspection log, Ohio EPA recommends the inspector use a sketch or a reduced photocopy of the site plan showing the location of storm water outfalls and storm drain inlets as well as the location and types of control measures. Problems observed at these locations, or at other locations on the construction site, should be highlighted and any corrective measures undertaken should be drawn in and noted in detail on the front side of the sketch. This method will also be helpful as the permittee is required to update the SWP3 to reflect current site conditions.

CONSTRUCTION ENTRANCES

Key things to look for ...

	Yes	No
1. Has the drive been constructed by placing geotextile fabric under the stone?	☐	☐
2. Is the stone 2-inch diameter?	☐	☐
3. Has the stone been placed to a depth of 6 inches, with a width of 10 feet and a length of at least 50 feet (30 feet for entrances onto individual sublots)?	☐	☐
4. If the drive is placed on a slope, has a diversion berm been constructed across the drive to divert runoff away from the street or water resource?	☐	☐
5. If drive is placed across a ditch, was a culvert pipe used to allow runoff to flow across the drive?	☐	☐

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

SEDIMENT PONDS

Key things to look for ...

	Yes	No
1. Are concentrated flows of runoff directed to a sediment pond?	☐	☐
2. Is sheet-flow runoff from drainage areas that exceed the design capacity of silt fence (generally 0.25 acre or larger) directed to a sediment pond?	☐	☐
3. Is runoff being collected and directed to the sediment pond via the storm sewer system or via a network of diversion berms and channels?	☐	☐
4. Is the sediment pond dewatering zone appropriately sized (67 cubic yards per acre of total drainage area)?	☐	☐
5. Is the sediment pond sediment settling zone appropriately sized (34 cubic yards per acre of disturbed area)?	☐	☐
6. Is the sediment basin riser outlet designed so that the dewatering zone will drain in no less time than 48 hours?	☐	☐
7. Have the embankments of the sediment pond and the areas that lie downstream of the pond been stabilized?	☐	☐
8. For sediment basins that dewater 100% between storms, is the riser pipe wrapped with chicken wire and double wrapped with geotextile fabric?	☐	☐
9. Does the riser have 1-inch diameter holes spaced 4 inches apart, both horizontally and vertically?	☐	☐
10. For sediment basins, which dewater 80% between storms, is the diameter of the dewatering hole per plan (see page 105 of <i>Rainwater</i> manual)?	☐	☐
11. For sediment traps, is there geotextile under the stone spillway and is the spillway saddle-shaped?	☐	☐
12. For sediment traps, which dewater 100% between storms, is the dewatering pipe end-capped, no larger than 6 inches in diameter, perforated and double-wrapped in geotextile?	☐	☐
13. Is the length-to-width ratio between inlet(s) and outlet at least 2:1? NOTE: If not, a baffle should be added to lengthen the distance.	☐	☐
14. Is the depth from the bottom of the basin to the top of the primary spillway no more than 3 to 5 feet?	☐	☐
15. For a modified storm water pond being used as a sediment pond, is the connection between the riser pipe and the permanent outlet water-tight?	☐	☐
16. Was the basin installed prior to grading the site?	☐	☐
17. Is it time to clean-out the sediment pond to restore its original capacity? Generally, sediment should be removed once the pond is half-full. Stabilize the dredged sediments with seed and mulch.	☐	☐

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

SILT FENCE

Key things to look for ...

	Yes	No
1. Is the fence at least 4" to 6" into the ground?	☐	☐
2. Is the trench backfilled to prevent runoff from cutting underneath the fence?	☐	☐
3. Is the fence pulled tight so it won't sag when water builds up behind it?	☐	☐
4. Are the ends brought upslope of the rest of the fence so as to prevent runoff from going around the ends?	☐	☐
5. Is the fence placed on a level contour? If not, the fence will only act as a diversion.	☐	☐
6. Have all the gaps and tears in the fence been eliminated.	☐	☐
7. Is the fence controlling an appropriate drainage area? Refer to page 119 of <i>Rainwater</i> manual. RULE OF THUMB: Design capacity for 100 linear feet of silt fence is 0.5 acres for slopes < 2%, 0.25 acres for slopes 2% to 20%, & 0.125 acres for slopes 20% or more. Generally, no more than 0.25 acres should lie behind 100 feet of fence at 2% to 10% slope, i.e., the distance between the fence and the top of the slope behind it should be no more than 125 feet. The allowable distance increases on flatter slopes and decreases for steeper slopes.	☐	☐

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

INLET PROTECTION

Key things to look for ...

	Yes	No
1. Does water pond around the inlet when it rains?	☐	☐
2. Has the fabric been replaced when it develops tears or sags?	☐	☐
3. For curb inlet protection, does the fabric cover the entire grate, including the curb window?	☐	☐
4. For yard inlet protection, does the structure encircle the entire grate?	☐	☐
5. Is the fabric properly entrenched or anchored so that water passes through it and not under it?	☐	☐
6. For yard inlet protection, is the fabric properly supported to withstand the weight of water and prevent sagging? The fabric should be supported by a wood frame with cross braces, or straw bales.	☐	☐
7. Is sediment that has accumulated around the inlet removed on a regular basis?	☐	☐

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

TEMPORARY STABILIZATION

Key things to look for ...

	Yes	No
1. Are there any areas of the site that are disturbed, but will likely lie dormant for over 21 days?	☐	☐
2. Have all dormant, disturbed areas been temporarily stabilized in their entireties?	☐	☐
3. Have disturbed areas outside the silt fence been seeded or mulched?	☐	☐
4. Have soil stockpiles that will sit for over 21 days been stabilized?	☐	☐
5. Has seed and mulch been applied at the proper rate? In general, seed is applied at 3 to 5 lbs per 1000 sq ft and straw mulch is applied at 2-3 bales per 1000 sq ft.	☐	☐
6. Has seed or mulch blown away? If so, repair.	☐	☐

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

PERMANENT STABILIZATION

Key things to look for ...

	Yes	No
1. Are any areas at final grade?	☐	☐
2. Has the soil been properly prepared to accept permanent seeding?	☐	☐
3. Has seed and mulch been applied at the appropriate rate (see page 169 of the <i>Rainwater</i> manual)?	☐	☐
4. If rainfall has been inadequate, are seeded areas being watered?	☐	☐
5. For drainage ditches where flow velocity exceeds 3.5 ft/s from a 10-year, 24-hour storm has matting been applied to the ditch bottom?	☐	☐
6. If the flow velocity exceeds 5.0 ft/s, has the ditch bottom been stabilized with rock rip-rap? NOTE: Rock check dams may be needed to slow the flow of runoff.	☐	☐
7. Has rock rip-rap been placed under all storm water outfall pipes to prevent scouring in the receiving stream or erosion of the receiving channel?	☐	☐
8. For sites with steep slopes or fill areas, is runoff from the top of the site conveyed to the bottom of the slope or fill area in a controlled manner so as not to cause erosion?	☐	☐

Note areas where repairs or maintenance is needed or where this practice needs to be applied:

NON-SEDIMENT POLLUTION CONTROL

Key things to look for ...

	Yes	No
1. Has an area been designated for washing out concrete trucks? Washings must be contained on site within a bermed area until they harden. The washings should never be directed toward a watercourse, ditch or storm drain.	☐	☐
2. Is waste and packaging disposed of in a dumpster? Do not burn them on site.	☐	☐
3. Are fuel tanks and drums of toxic and hazardous materials stored within a diked area or trailer and away from any watercourse, ditch or storm drain?	☐	☐
4. Are streets swept as often as necessary to keep them clean and free from sediment? NOTE: Sediment should be swept back onto the lot - not down the storm sewers.	☐	☐
5. Are stockpiles of soil or other materials stored away from any watercourse, ditch or storm drain?	☐	☐
6. Have stream crossings been constructed entirely of non-erodible material?	☐	☐
7. If an area of the site is being dewatered, is it being pumped from a sump pit or is the discharge directed to a sediment pond? NOTE: if you must lower ground water, the water may be discharged to the receiving stream as long as the water remains clean. Be sure not to co-mingle the clean ground water with sediment-laden water or to discharge it off-site by passing it over disturbed ground.	☐	☐

Note areas where repairs or maintenance is needed or where this practice needs to be applied:



Division of Surface Water - Notice of Termination (NOT) of Coverage Under Ohio Environmental Protection Agency General NPDES Permit

(Read accompanying instructions carefully before completing this form.)			
Submission of this NOT constitutes notice that the party identified in Section II of this form is no longer authorized to discharge into state waters under the NPDES general permit program. NOTE: All necessary information must be provided on this form. Do not use correction fluid on this form. Forms transmitted by fax will not be accepted. There is no fee associated with submitting this form.			
I. Permit Information			
NPDES General Permit Number: OH			
Facility General Permit Number:			
II. Owner/Applicant Information/Mailing Address:			
Company (Applicant) Name:			
Mailing (Applicant) Address:			
City:	State:	Zip Code:	
Contact Person:	Phone:	Fax:	
Contact E-mail Address:			
III. Facility/Site Location Information			
Facility Name:			
Facility Address/Location:			
City:	State:	Zip Code:	
County:	Township:	Section:	
Facility Contact Person:	Phone:	Fax:	
Contact E-mail Address:			
IV. Reason for Termination			
Transfer of Ownership ☐	Cease to Discharge ☐	Facility Closed ☐	
Project Completed ☐	Obtained Individual Permit ☐		
V. Certifications			
Standard Certification:			
I certify under penalty of law that all discharges authorized by the NPDES general permit have been eliminated or that I am no longer the operator of the facility. I understand that by submitting this NOT, I am no longer authorized to discharge under this general permit and that discharging pollutants to waters of the state without an NPDES permit is unlawful under ORC 6111.			
Name (typed):		Title:	
Signature:		Date:	
Industrial Storm Water and Coal Mining Activity Certification Only:			
I certify under penalty of law that all discharges associated with the identified facility that are authorized by the above referenced NPDES general permit have been eliminated, that I am no longer the operator of the facility, or in the case of a coal mine that the SMCRA bond has been released by ODNR-Division of Reclamation. I understand that by submitting this NOT, I am no longer authorized to discharge storm water associated with industrial activity under this general permit, and that discharging pollutants in storm water associated with industrial activity to waters of the state is unlawful under ORC 6111 where the discharge is not authorized by an NPDES permit.			
Name (typed):		Title:	
Signature:		Date:	
Storm Water Construction Activity Certification Only:			
I certify under penalty of law that all elements of the storm water pollution prevention plan have been completed, the disturbed soil at the identified facility have been stabilized and temporary erosion and sediment control measures have been removed at the appropriate time, or that all storm water discharges associated with construction activity from the identified facility that are authorized by the above referenced NPDES general permit have otherwise been eliminated. I understand that, by submitting this NOT, I am no longer authorized to discharge storm water associated with construction activity by the general permit, and that discharging pollutants in storm water associated with construction activity to waters of the state is unlawful under ORC 6111 where the discharge is not authorized by an NPDES permit.			
Name (typed):		Title:	
Signature:		Date:	



Notice of Termination (NOT) Form Instructions For Ohio EPA General Permits

Where to file NOT form

NOTs must be sent to the following address:

Ohio Environmental Protection Agency
General Permit Program
P.O. Box 1049
Columbus, OH 43216-1049

Completing the Form

Please complete the fill-in form on-line at www.epa.ohio.gov/dsw/storm/stormform.aspx or print legibly in the appropriate areas only. Forms transmitted by FAX will not be accepted. Complete all sections of the NOT form. Incomplete forms will be returned to the applicant for resubmittal.

Please place each character slightly above the appropriate line. Abbreviate if necessary to stay within the space allowed for each item.

Section I - Permit Information

Enter the existing Ohio NPDES general permit number assigned to the facility or site for which you are submitting this NOT. If you do not know the permit number, contact the Ohio EPA Storm Water Section at (614) 644-2001.

Section II - Owner/Applicant Information/Mailing Address

This information should appear on the NOT form as it appears on the original Notice of Intent (NOI) form.

Give the legal name of the person, firm, public organization, or any other entity that operates the facility or site described in the application. The name of the operator may or may not be the same as the facility. The operator of the facility is the legal entity which controls the facility's operation rather than the plant or site manager. For construction activities, the responsible party is the owner or the developer of the property. Do not use a colloquial name. Give the name and phone number of a contact person who is responsible for addressing NPDES permit requirements. Enter the complete address and telephone number of the operator (provide phone number as: area code exchange number).

Section III - Facility/Site Location Information

This information should appear on the NOT form as it appears on the original Notice of Intent (NOI) form.

Enter the facility's or site's official or legal name and complete address, including city, state, zip code, county, township, and section. If the facility lacks a street address, indicate the street name and approximate address number.

Section IV - Reason for Termination

Indicate your reason for submitting this NOT by placing an "X" on the appropriate space. You may indicate more than one reason.

Standard Certification

The standard certification should be completed except where a specific certification (listed below) is required.

Industrial Storm Water and Coal Mining Activity Certification Only

This certification should be completed only if you are submitting this NOT to terminate permit coverage under the storm water general permit associated with industrial activity or the general permit associated with coal mining activity.

Construction Certification Only

This certification should be completed only if you are submitting this NOT to terminate permit coverage under the storm water general permit associated with construction activity.

Note for all certifications: provide date as month day year using 2 digits for each space.

Signatory Requirements

Federal statutes provide for severe penalties for submitting false information on this application form. Federal regulations require this application to be signed as follows.

For a corporation: by a responsible corporate officer, which means: (1) a president, secretary, treasurer or vice-president of the corporation in charge of a principal business function or any other person who performs similar policy or decision-making functions for the corporation; or (2) the manager of one or more manufacturing, production or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

For a partnership or sole proprietorship: by a general partner or the proprietor; or

For a municipality, state, federal, or other public facility: by either a principal executive officer or ranking elected official

SECTION 32 12 00

FLEXIBLE PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Asphalt concrete pavement shown on the Drawings and required by the Specifications constructed on a prepared surface in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or otherwise specified.
- B. Coordinate work of other trades who will be working adjacent to paving areas. Coordinate work with Contractor providing compacted base for paving materials.
- C. Inspection and Testing Services required by this Section are to be performed by an Agency retained by the Contractor and approved by the Owner. This includes all field sampling and testing required by the Field Quality Control Section of this Specification.
- D. Related Sections:
 - 1. Section 31 00 00, "Earthwork"
 - 2. Section 31 23 33, "Piped Utilities - Basic Methods"
 - 3. Section 32 13 00, "Rigid Pavement"
 - 4. Section 03 30 00, "Cast-in-Place Concrete"
- E. Do not place asphalt surface course until site work has been completed and construction traffic has been reduced to a minimum.

1.02 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. The Asphalt Institute – Manual MS-2 – Mix Design Methods.
 - 2. The Asphalt Institute – Manual MS-4 – The Asphalt Handbook.
 - 3. The Asphalt Institute – Manual MS-13 – Asphalt Surface Treatments and Asphalt Penetration Macadam.
 - 4. ASTM D946 – Asphalt Cement for Use in Pavement Construction.
 - 5. ASTM D1188 – Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Paraffin Coated Specimens.
 - 6. ASTM D2041 – Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - 7. ASTM D2950 – Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
 - 8. State of Ohio, Department of Transportation – Construction and Materials Specifications (CMS) 2019.
 - 9. City of Columbus, Ohio - Construction and Material Specifications (CCMS) 2018.
- B. Regulatory Requirements:
 - 1. Conform to applicable City standards for paving work on public property. In the event of a conflict between the Drawings and Specifications and the City standards, the City standards shall govern. No extra charges will be allowed for any changes necessary for compliance with City standards.

2. Perform work in accordance with State of Ohio, City of Columbus, Department of Transportation Construction and Material Specifications, 2019.
3. Mixing Plant: Conform to State of Ohio, City of Columbus, Department of Transportation, Construction and Material Specifications, 2019.

C. Weather Limitations:

1. Place bituminous pavement only when the surface is dry and when weather conditions are such that proper handling, finishing and compaction can be accomplished. In no case, however, shall bituminous pavement be placed when the surface temperature is below the minimum established in the following table:

COURSE THICKNESS	MINIMUM SURFACE TEMPERATURE
1.5 Inches and Over	40°F
1.0 to 1.4 Inches	50°F
Less than 1.0 Inches	60°F

1.03 SUBMITTALS

- A. Submit for approval the mixing plant to be used.
- B. Submit approved job mix formulas for each asphalt concrete pavement prior to preparation of the mixture.
- C. Submit all aggregate and asphalt binder test data, as required.
- D. Submit product data and manufacturer's instructions, including traffic paint.
- E. Submit for approval the name of agency proposed for the required inspection and testing services. All of the required field testing and sampling is to be performed by personnel employed by the proposed agency.
- F. Submit reports of all required testing and inspection.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Surface Course: Asphalt Concrete Surface Course, Type 1, medium or light traffic, PG 70-22M CCMS Item 441.
 1. Refer to drawings and details for extent of medium and light traffic designations.
- B. Intermediate Course: Asphalt Concrete Surface Course, Type 2, medium or light traffic, PG 70-22M CCMS Item 441.
 1. Refer to drawings and details for extent of medium and light traffic designations.
- C. Tack Coat: CCMS Item 407.
- D. Bituminous Base Course: Asphalt Concrete Base, PG 64-22 CCMS Item 301.
- E. Aggregate Base Course: CCMS Item 304.

2.02 EQUIPMENT

- A. Spreading Equipment: Provide self-contained spreading equipment of sufficient size, power, and stability to receive, distribute, and strike-off the bituminous mixture at rates and widths commensurate with the typical sections and other details shown on the plans. Provide equipment with automatic control systems which maintain the screed in a constant position relative to profile and cross-slope references. These references shall be such that control of the screed position is reasonably independent of irregularities in the underlying surface and of the spreader operation.
- B. Rollers: Provide rollers of the standard steel wheel and pneumatic tire types and meeting the requirements of CCMS Item 401.12.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify compacted subgrade base is dry and ready to support paving and imposed loads.
- B. Proof roll subgrade and correct any areas determined unacceptable to Testing Agency, in accordance with the Agency's recommendations immediately prior to placement of asphalt pavement.
- C. Verify gradients and elevations of base are correct.
- D. Beginning of installation means acceptance of substrate.
- E. Protect existing surfaces and structures adjacent to paving. Repair any damage caused by paving operations at no additional cost to the Owner.

3.02 CONDITIONING EXISTING SURFACE

- A. Immediately prior to the arrival of pavement mixtures, thoroughly clear the pavement base, leveling course, or old pavement of all soil, grass, dirt, or other foreign materials.
- B. When the surface of the existing pavement is irregular, bring to uniform grade as directed using the material specified. Paint contact surfaces of curbing, gutters, manholes, and other structures with a thin, uniform coating of bituminous material prior to the bituminous mixture being placed against them.
- C. Where mixture is to be placed against the vertical face of rigid pavement, clean vertical face of foreign material and give an application of bituminous material in a manner which results in a coating of approximately 1/4 gallon per square yard.
- D. Coat surfaces of catch basin frames with oil to prevent bond with asphalt paving.

3.03 PAVEMENT REPAIR

- A. Saw cut perimeter of pavement repair. Extend saw cut fully through the existing surface and asphaltic base material, enabling the removal of the existing failed pavement, leaving a neat and straight edge.

- B. Completely excavate the existing pavement section in areas of repair and remove from the site. Use excavating equipment which shall not damage existing pavement to remain.
- C. In the event that the entire pavement section is removed, proof roll the area. Undercut and replace any existing subbase that is soft and yielding with CCMS Item 304. Remove all unsuitable subgrade material excavated from the pavement repair area from the site. Proof roll in the presence of the Testing Agency. Payment shall be made per contract conditions relative to changes in work.
- D. Where mixture is to be placed against the vertical face of an existing pavement structure, clean the vertical face of foreign material and give an application of tack coat.

3.04 PAVEMENT RESURFACING

- A. Coordinate junction of new and existing pavement. Where new overlay abuts existing pavement, scarify a minimum of 4 feet wide and depth equal to overlay thickness to provide butt joint. Feathering will not be permitted.
- B. Scarify areas around existing structures 4'-0" wide, such that the new overlay will be placed to meeting existing surface level. Maintain positive drainage slopes.
- C. Scarify by milling, grinding or cold planning the existing pavement surface to establish a new surface profile and cross section in preparation for the asphaltic overlay. Provide a surface after grinding that is grooved or ridged finish uniform and resistant to raveling or traffic displacement. Provided a textured surface that has grooves of 0.25 inches in width.
- D. Include grinding around utility castings in the area of the pavement scarified. The At Contractor's option remove the entire existing bituminous pavement around the castings where grinding is not completed and replace it with bituminous surface course placed and compacted in 3 inch lifts. Vertically cut the limits of the area to be patched, mechanically compact the existing base course, and prime the bottom and vertical edges before backfilling.
- E. Provide a power operated, self-propelled grinding machine with a cutting drum with lacing patterns that will attain a grooved surface and produce a pressurized watering system for dust control.
- F. Thoroughly clean all areas to be resurfaced. Do not flush cleanup water into the storm sewer system. Remove waste debris cleaned from the site.
- G. Provide asphaltic concrete overlay in areas of resurfacing according to the Drawings and this entire Specification Section, as applicable.

3.05 PREPARATION, MIXING, AND HAULING OF MIXTURE:

- A. Preparation:
 - 1. Bituminous Material Preparation: Heat bituminous material and deliver to the mixer within the temperature range specified in CCMS Item 702. Do not use foaming bituminous materials.

2. Aggregate Preparation: Feed aggregates to the cold elevator in their proper proportions at a rate permitting correct and uniform control of heating and drying. Remove all aggregates in the hot bins that will produce a mix outside the temperature limits or that contain sufficient moisture or expanding gases to cause foaming in the mixture and return to the proper stockpiles.
- B. Mixing:
1. After all of the aggregate is in the mixer, add bituminous material in an evenly spread sheet over the full length of the mixer. The mixing time shall be the time interval between the start of the application of the bituminous material and the opening of the mixer gate. Mix bituminous material for a minimum of 30 seconds. Discharge all bituminous material in no more than 30 seconds.
 2. Maintain temperatures of the mixture at the plant in order to be placed at the temperatures specified in Paragraph 3.06.
- C. Hauling:
1. Use trucks for hauling bituminous mixtures that have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of approved material to prevent the mixture from adhering to the beds. Provide each truck a securely fastened, waterproof cover of suitable material to adequately protect the mixture from the wind and weather. Remove covers prior to dumping mixture into the paver.
 2. When hot mixtures are being transported at prevailing air temperatures below 50° F or when the length of haul exceeds 20 miles, insulate all truck beds to maintain the specified temperature of the mixture. Do not haul distances in excess of 50 miles unless specifically approved by the Engineer.

3.06 SPREADING

- A. Place tack coat prior to placing surface course or intermediate course per CCMS Item 407.
- B. Spread the pavement mixture on an approved surface with bituminous pavers or spreaders to achieve the specified thickness and compaction. Maximum compacted depth of any one layer shall be as follows:
1. Bituminous Aggregate Base Course: 6 inches
 2. Intermediate Course: 3 inches
 3. Surface Course: 3 inches
- C. Immediately after the mixture is spread, correct irregularities in grade and alignment by the addition or removal of the mixture before compaction has started.
- D. Remove and replace any areas showing an excess or deficiency of bituminous material before or after compaction.
- E. In areas where irregularities or unavoidable obstacles make the use of mechanical spreading equipment impracticable, spread or rake the mixture with hand tools. For such areas, dump, spread, and screen the mixture to give the specified thickness and compaction.

3.07 COMPACTION

- A. Provide a bituminous mixture with a minimum temperature of 270 degrees F prior to placing in the paver. Immediately after the bituminous mixture has been spread, struck off, and surface irregularities adjusted, thoroughly and uniformly compact by rolling.
- B. Coordinate the spreading of the mixture with the required roller coverage, considering the rate of cooling of the mixture as affected by lift thickness and environmental conditions. Complete final rolling before the pavement reaches a temperature of 180 degrees F.
- C. Along curbs, headers, walls, and in other areas not accessible to rollers, thoroughly compact the mixture with hot, hand tampers or with mechanical tampers.
- D. For all hot bituminous mixtures, provide the number and type of rollers sufficient to compact the mixture at the rate of spreading without exceeding the capacity of the rollers in operation. Compact base, intermediate, and surface courses with a combination of both steel and Type I pneumatic tire rollers, except in small areas which may be compacted by hand tools.
- E. Unless otherwise directed, begin rolling at the outer edges and proceed longitudinally at a slow, uniform speed. After each coverage or complete round trip, progress the roller by overlapping the previous pass by at least half of the width of the roller.
- F. Continue rolling until full coverage of the course has been completed and all roller marks are eliminated.
- G. Replace mixture that becomes loose, broken, contaminated, or otherwise defective with fresh, hot mixture compacted to conform with the surrounding area.
- H. After compaction of the surface course, seal curbs and gutters with asphalt binder. Apply mixture at a uniform width and at a rate just sufficient to fill surface voids.
- I. Do not allow traffic to travel on the compacted pavement until it has cooled sufficiently to prevent glazing.

3.08 JOINTS

- A. Place bituminous paving as continuously as possible. Make longitudinal and transverse joints as a vertical face. Set up joints at the proper height above the adjacent finished pavement to receive maximum compaction.
- B. Provide a well bonded and sealed joint. Coated joint with a 4 inch wide strip of asphalt material along the entire length of the joint.

3.09 TRAFFIC PAINT

- A. Paint all lines, arrows and other markings in accordance with CCMS Section 640 as required to define parking spaces and traffic flow on pavement as indicated on Drawings. Provide handicapped logos at all handicapped parking spaces.
- B. Paint lines approximately 4 inches wide with even, clean edges and neat, sharp lines.

- C. Apply by highway-type applicator machine in heavy one-coat application in method and coverage recommended by paint manufacturer. Do not hand paint any lines.
- D. Apply traffic paint at the completion of the project when no more construction traffic is expected in the area.

3.10 SPREADING AND SURFACE TOLERANCES

- A. Maintain the rate of spreading within a tolerance of 5 percent of the required calculated weight to achieve proper course depth and compaction.
- B. Do not vary elevation of finished surface course from true elevation by more than 1/4 inch.
- C. Do not vary transverse slope of the surface of the completed course from the specified slope by more than 3/8 inch in 10 feet.
- D. Do not vary transverse slope of the surface of the completed course from the testing edge of a 10 foot straightedge by more than the tolerance specified:
 - 1. Bituminous Aggregate Base course: 3/8 inch.
 - 2. Intermediate course: 1/4 inch.
 - 3. Surface course: 1/4 inch.
- E. Remove and replace portions of the completed pavement that are defective in surface, compression, or composition or otherwise correct in a manner satisfactory to the Engineer.

3.11 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Bituminous Thickness Testing: Provide thickness measurement of field core samples per ASTM D1188 within 48 hours after the pavement is placed. Perform tests as follows:
 - 1. One passing thickness test for each 500 square yards or each lift, whichever is less.
 - 2. Provide random locations of cores or as directed by the Testing Agency. Clearly identify horizontal location at each test core on test reports.
 - 3. Allowable compacted pavement thickness shall be within + 0.25 inches of specified thickness.
 - 4. Fill core holes by the next working day. Before filling, ensure the holes are dry and tack with asphalt material conforming to CCMS Item 407.02. Properly compact the asphalt concrete used to fill the hole leave flush with adjacent pavement.
- C. Bituminous Density Testing: Provide density testing of placed bituminous pavement per ASTM D1188 and ASTM D2950 within 48 hours after the pavement is placed. Theoretical average Maximum Specific Gravity (MSG) shall be determined per ASTM D2041. Perform tests as follows:
 - 1. One passing density test for each 500 sq. or each lift, whichever is less.
 - 2. Provide random locations of tests or as directed by Testing Agency. Test reports shall clearly identify horizontal location at each test location.
 - 3. Provide compaction ranging from 90.0 to 97.9 percent of the average Maximum Specific Gravity (MSG) for Surface Course and 90.0 to 96.9 percent for Intermediate Course. Remove and replace any material placed outside of said ranges. Provide replacement pavement and quality assurance testing at no additional cost to the Owner.

4. Fill core holes by the next working day. Before filling, ensure the holes are dry and tack with asphalt material conforming to CCMS Item 407.02. The asphalt concrete used to fill the hole shall be properly compacted and shall be left flush with adjacent pavement.

3.12 ACCEPTANCE

- A. Asphalt surface not conforming to sections "Spreading and Surface Tolerances" and "Field Quality Control" and/or exhibiting ponding after rain events are subject to rejection and removal and replacement at no cost to the Owner.
- B. When Field Quality Control testing or observations indicate that the Contract requirements have not been met, the Contractor is to bear the costs of any additional testing any analysis to determine acceptability and also the cost of removal and replacement, if such is required.

3.13 PROTECTION

- A. Immediately after placement, protect pavement under provisions of Division 1 from mechanical injury. Maintain clean pavement surface throughout the remainder of the project. Immediately remove any construction debris or soil tracked on new asphalt.
- B. If pavement surface becomes faded or dirty prior to completion of project, clean and seal parking lot prior to applying traffic paint.
- C. Protection of Work by Others: Protect all work by others such manholes, catch basins, sewer cleanouts, lighting posts and bases, sidewalks, etc. Damage to same shall be repaired at the Paving Contractor's expense.

END OF SECTION

SECTION 32 13 00

RIGID PAVEMENT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Concrete sidewalks, detectable warnings, curbs, gutters, and streets.
- B. Reinforcement.
- C. Surface finish.
- D. Curing

1.02 WORK INSTALLED BUT FINISHED UNDER OTHER SECTIONS

- A. Not used.

1.03 RELATED WORK

- A. Section 31 00 00, "Earthwork"
- B. Section 32 12 00, "Flexible Pavement"
- C. Section 33 40 00, "Storm Drainage"
- D. Section 03 30 00, "Cast-in-Place Concrete"

1.04 REFERENCES

- A. ACI 301 - Specifications for Structural Concrete for Buildings.
- B. ASTM D1751-99 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- C. ASTM D1752-04a – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- D. ASTM C33-03 - Standard Specification for Concrete Aggregates.
- E. ASTM C94-04a - Standard Specification for Ready Mixed Concrete.
- F. ASTM C150-04a - Standard Specification for Portland Cement.
- G. ASTM C260-01 - Standard Specification for Air-Entraining Admixtures for Concrete.
- H. ASTM C309-03 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- I. ASTM C494-04 - Standard Specification for Chemical Admixtures for Concrete.

- J. ASTM C920-02 – Standard Specification for Elastomeric Joint Sealants.
- K. ASTM D5249 – Standard Specification for Backer Material for Use with Cold and Hot Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints.
- L. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.
- M. State of Ohio Department of Transportation Construction and Material Specifications (CMS) 2019.
- N. City of Columbus, Ohio Construction and Material Specifications (CCMS) 2018.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Obtain materials from same source throughout.
- C. Install curb and gutter in accordance with CCMS Item 609.

1.06 REGULATOR REQUIREMENTS

- A. Conform to City code for paving work on public property.

1.07 TESTS

- A. Testing and analysis will be performed under provisions of Division 1.
- B. Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of work.
- C. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.

1.08 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Include data on joint filler, admixtures, curing compounds.
- C. Submit manufacturer's instructions under provisions of Division 1.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Cement: ASTM C150-86, Type I, II or III Portland type, gray color.
- B. Fine and Coarse Aggregate: ASTM C33-86.
- C. Water: Potable.

2.02 FORM MATERIALS

- A. Conform to ACI 301.
- B. Joint Filler: ASTM D1751-83.

2.03 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615; 60 ksi yield grade.
- B. Welded Steel Wire Fabric: Plain type, ANSI/ASTM A175; in flat sheets.
- C. Tie Wire: Annealed steel, minimum 16 gauge.
- D. Dowels: ASTM A615; 40 ksi yield grade, plain steel, uncoated finished.
- E. Synthetic Fiber Reinforcement: ASTM C1116-97 and ASTM C1018-97. Acceptable products include, but are not limited:
 - 1. Nycon Nylon Fibers.
 - 2. Forta Nylo-Mono Nylon Fibers
 - 3. Fibermesh Fibermix Stealth Polypropylene Fibers.
 - 4. Grace Polypropylene Fibers
 - 5. Forta Mighty-Mono Polypropylene Fibers

Synthetic fiber reinforcement shall be used in strict accordance with the manufacturer's recommendations. Dosage rate shall be as recommended by the manufacturer, but not less than 1 pound per cubic yard.

2.04 ACCESSORIES

- A. Dissipating Curing Compound: Comply with ASTM C309-98a, Type 1, Class A or B (clear), except moisture loss not to exceed 0.40 kg/sq m. in 72 hours. Compound shall comply with EPA's VOC requirements. Apply at the manufacturer's written recommended application rate.
- B. Sealer: Clear membrane-forming compound which will not yellow. Must be formulated for the intended application, either interior or exterior and applied per the manufacturer's written recommendations. Must comply with EPA's VOC requirements and be compatible with the curing compound used.
- C. Penetrating Sealer: Acceptable products include, but are not limited to:
 - 1. L&M Construction Chemicals - Aquapel Plus 40
 - 2. ProSoCo - Saltguard WB
 - 3. Huls America Inc. - Chem-Trete BSM 40
 - 4. Master Builders Inc. - Masterseal SL 40
 - 5. Lyntal International - Iso-Flex 618-50 WB
 - 6. BASF - Enviroseal 40 or Hydrozo Silane 40
 - 7. Tex-Cote - Rainstopper RS140

D. Expansion, Isolation, and Construction Joints:

1. Pre-formed Joint Filler: Non-impregnated type, closed cell resilient polyethylene foam, 1/2 inch thick unless otherwise noted. Meet or exceed requirements of ASTM D 1752, Sections 5.1 through 5.4, and ASTM D 5249, Type 2. Ceramar Flexible Foam Expansion Joint by W.R. Meadows or approved equal.
2. Joint Cap: Two piece vinyl device with upper 1/2 inch removable after curing period. Width corresponding to joint filler. Products by Greenstreak Plastic Products, Vinylex Corp., Vulcan Metal Products, or approved equal.
3. Joint Sealant: High performance, self leveling, elastomeric polyurethane sealant conforming to ASTM C-920. Sikaflex 1CSL or approved equal.

2.05 ADMIXTURES

- A. Air Entrainment: ASTM C260-86.
- B. Chemical Admixture: ASTM C494-86, Type A or D - water reducing, Type C or E - accelerating.

2.06 CONCRETE MIX

- A. Mix concrete in accordance with ASTM C94.
- B. Provide concrete for the following characteristics:
 - Compressive Strength at 28 days: 4000 psi.
 - Min cementitious materials content 564 lbs./cu. yd.
 - Max water-cementitious ratio 0.45, air content 6+1, -1.5%
- C. Use accelerating admixtures in cold weather only when approved by Architect/Engineer. Use of admixtures will not relax cold weather placement requirements.
- D. Use set-retarding admixtures during hot weather only when approved by Architect/Engineer.
- E. Add air entraining agent to concrete mix for concrete work exposed to exterior.
- F. Concrete mixes shall not contain any deleterious or other reactive aggregates or materials that can initiate and promote alkali silica reaction (ASR).

2.07 DETECTABLE WARNINGS

- A. Detectable warning surfaces shall contrast visually with walking surfaces and be textured to provide slip resistance. The preferred color for a light background shall be brick red. The preferred color for a dark background shall be light granite. Color shall be integral with the detectable warning surface and shall not be painted or surface applied.
- B. Detectable warning surface shall have truncated domes with a consistent base diameter ranging from 0.9 inches 1.4 inches. Truncated domes shall have a height of 0.2 inches and a top diameter ranging from 50 to 65 percent of the base diameter.

- C. Truncated domes shall have a consistent spacing ranging from 1.6 inches to 2.4 inches measured center-to-center. Base-to-base spacing measured between the most adjacent domes shall be 0.65 inches minimum.
- D. Detectable warning surfaces shall be of the type specified on the drawings:
 - 1. Type I – Pre-Manufactured Wet-Set Products
 - 2. Type II – Stamped, Color Dyed Concrete
 - 3. Type III – Precast Manufactured Clay and Concrete Pavers
- E. Contractor shall submit detectable warning surface product data for review prior to construction.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify compacted subgrade or granular base stabilized soil is ready to support paving and imposed loads.
- B. Proof roll subgrade and correct any areas determined unacceptable to Testing Agency immediately prior to placement of concrete pavement.
- C. Verify gradients and elevations of base are correct.
- D. Beginning of installation means acceptance of existing conditions.
- E. Proof roll prior to base placement.

3.02 REINFORCEMENT

- A. Place reinforcement at mid-height of slabs-on-grade.
- B. Interrupt reinforcement at expansion joints.
- C. Place reinforcement to achieve slab and curb alignment as detailed.
- D. Provide dowelled joints at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement, per ODOT Item 451.

3.03 JOINTS

- A. Location: Locate as shown on drawings. In absence of information on drawings, provide joints as specified below.
- B. Control Joints: Created within 8 hours of concrete placement. Sawed typical, tooled where allowed by the Engineer.
 - 1. Slabs:
 - a. Spacing (in feet) shall be between 2 to 2-1/2 times slab thickness (in inches) in both directions, i.e., 4-inch thick slab shall have joint spacing at 8 foot to 10 foot centers.

- b. Grid of control joints to be approximately square with longest side to be not longer than 1.5 times the shortest side, i.e., 4-foot wide walk shall have joint spacing at 4 feet to 6 feet maximum.
 - c. Depth of Joint: 1/4 of slab thickness.
 - d. Width of Joint: 1/8 inch.
 - 2. Curbs:
 - a. Maximum 10 feet on center. Aligned with joints in adjacent vehicular paving and sidewalks.
 - b. Depth of Joint: 1-1/2 inches minimum.
 - c. Width of Joint: 1/8 inch.
- C. Isolation Joints: Formed before concrete placement.
 - 1. Location in Slabs and Curbs: Provide where slabs and curbs abut vertical surfaces: at intersections of sidewalks, abrupt changes in slab width, walls, columns, pole bases, outside face or edge of curbs, and manholes, catch basins, or curb inlets.
 - 2. Joint: Provide 1/2 inch wide Pre-formed Joint Filler with removable 3/8 inch deep Joint Caps. Joint Cap shall be set to finish grade elevation. After concrete has set, Joint Cap shall be removed and filled with 3/8 inch of Joint Sealant. Clean joint surfaces free from dirt, dust, and other contaminants that may affect the bond of the joint sealant material. Install Joint Sealant per manufacturer's specifications
 - a. Slabs: Provide Pre-formed Joint Filler to full depth of slab minus 3/8 inches to allow for installation of Joint Cap and Joint Sealant.
 - b. Curbs: Provide Pre-formed Joint Filler to full depth of curb. Joint Filler material shall be cut to match contour of face of curb minus 3/8 inches to allow for installation of Joint Cap and Joint Sealant.
- D. Expansion Joints: Formed before concrete placement. Provide when specifically shown on the drawings or when placing concrete during temperatures less than 40 degrees Fahrenheit.
 - 1. Location:
 - a. Slabs: Space maximum of 25 feet on center.
 - b. Curbs: Align with joints in pavement. In absence of concrete pavement, provide at intervals not exceeding 25 feet.
 - 2. Joint: Provide 1/2 inch wide Pre-formed Joint Filler with removable 3/8 inch deep Joint Caps. Joint Cap shall be set to finish grade elevation. After concrete has set, Joint Cap shall be removed and filled with 3/8 inch of Joint Sealant. Clean joint surfaces free from dirt, dust, and other contaminants that may affect the bond of the joint sealant material. Install Joint Sealant per manufacturer's specifications
 - a. Slabs: Provide Pre-formed Joint Filler to full depth of slab minus 3/8 inches to allow for installation of Joint Cap and Joint Sealant.
 - b. Curbs: Provide Pre-formed Joint Filler to full depth of curb. Joint Filler material shall be cut to match contour of face of curb minus 3/8 inches to allow for installation of Joint Cap and Joint Sealant.
- E. Construction Joints: Clean, formed joints shall be set at predetermined locations and/or when 30 minutes elapses between successive pours of concrete.
 - 1. Slabs: Provide Pre-formed Joint Filler, Joint Cap, and Joint Sealant at predetermined location. Joint shall be similar to Isolation Joint specified previously.
 - 2. Curbs: Provide Pre-formed Joint Filler, Joint Cap, and Joint Sealant at predetermined location. Joint shall be similar to Isolation Joint specified previously.

3.04 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301.
- B. Hot Weather Placement: ACI 305.
- C. Cold Weather Placement: ACI 306.
- D. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- E. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- F. Excavate, shape and compact subgrade for suitable bearing surface. Remove unacceptable material. Remove all roots occurring within 12 inches of nearest concrete surface. Fill depressions with acceptable material and compact.
- G. Place, shape, and compact aggregate base to required section and grade. Provide 4 inch base course unless indicated otherwise.
- H. Provide suitable forms of metal, wood or as approved to contain concrete to indicated line, grade and shape until set. Provide face forms for curb and other sections free of defects and conforming to indicated shapes. Provide side forms to full depth of concrete. Use approved flexible forms or curved forms of proper radius on curves having a radius of 150 feet or less.
- I. Coat all forms with form treating material prior to placing concrete to prevent concrete damage during form removal.
- J. Concrete mixing: ACI 301, Chapter 7, ready-mixed unless permission is given to site mix.
- K. Place control, isolation, and expansion joints as indicated on Drawings and as specified previously.
- L. Immediately before concrete placement, thoroughly wet all moisture absorbing material that will be in contact with the concrete. Standing water not permitted.
- M. Place concrete in forms without segregation. Vibrate or hand tamp to remove voids. Strike off concrete and float smooth.
- N. Do not place concrete on frozen ground.
- O. Finish concrete as specified.
- P. Place backfill using required material as soon as possible without damaging concrete.
- Q. Repair or remove and replace damaged concrete as directed. Conform to ACI 301, Chapter 9.
- R. Curing:
 - 1. ACI 301, Chapter 12. Use waterproof sheet materials or liquid membrane.
 - 2. Surfaces which are to receive penetrating sealer are to be moist cured without the use of a curing compound.

- 3. Dissipating curing compound may be used, if completely removed prior to application of penetrating sealer.
- S. Place expansion joints as indicated on Drawings. In addition, place where concrete surrounds or adjoins any existing fixed objects such as fire hydrants, columns, building foundations, and other rigid structures.
- T. Maximum allowable deviation of formed edges from indicated location: 1/2 inch. Maximum allowable deviation of surface: 1/8 inch when checked with a 10 foot straight edge. Remove to nearest joint and replace any walk or slab exceeding stated deviations.
- U. Slope walks and slabs away from buildings as indicated but not less than 1/8 inch per foot. Maintain design drainage grades to avoid low spots trapping water.
- V. After water sheen has disappeared, lightly brush surface to a uniform texture unless otherwise indicated or directed. Edge joints to provide a smooth border around each panel.
- W. Appearance: Take special precautions in material sources, mixing, delivery, and placement of walks to insure uniform appearance and coloration throughout the entire walkway. Variations in coloration, texture, and finish of any given type of walkway will be unacceptable.
- X. Do not remove forms for minimum of 12 hours after finishing.

3.05 FINISHING

- A. Sidewalk Paving: Light broom, radiused and trowel joint edges.
- B. Curbs and Gutters: Light broom.
- C. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.06 PENETRATING SEALER

- A. Remove all dust, dirt, laitance, and other contaminants. Remove curing compound completely, if used.
- B. Provide test patches as required to ensure compatibility and effectiveness.
- C. Apply with spray or roller, at the manufacturer's written recommended coverage rate, to the following surfaces:
 - 1. Horizontal top surface of all concrete exposed to the weather.
 - 2. Vertical surfaces of columns, walls, curbs, etc. within 12 inches of a treated horizontal surface.
- D. Entire application is to be in strict conformance with the manufacturer's written requirements.

3.07 DETECTABLE WARNINGS

- A. Detectable warning surface shall extend the full width of travel of the curb ramp or landing. Warning surface shall extend a minimum of 24 inches in the direction of travel.

- B. The detectable warning surface shall be located such that the edge of the detectable warning nearest the curb line is 6 inches from the face of curb.
- C. Truncated domes shall be aligned in a square grid and must not be skewed diagonally in the direction of travel. Truncated domes shall be aligned in rows parallel and perpendicular to the direction of travel.
- D. The detectable warning finish surface shall be uniformly profiled to match the adjacent pavement surfaces without lips or obstructions.
- E. Type I and Type II Detectable warning surfaces shall be installed in accordance with the manufacturer's specifications.
- F. Type III Precast Manufactured Clay and Concrete pavers shall be installed per the manufacturer's specifications or as follows:
 - 1. Pavers shall be laid on a 4 inch thick unreinforced concrete base and set into a 1/2 inch thick bed of freshly poured latex or epoxy modified cement mortar.
 - 2. Pavers (excluding dome surface) shall be flush with the surrounding concrete.
 - 3. Joints between pavers and adjacent concrete shall be mortared flush and smooth with the adjacent surface and shall not exceed 1/4 inch in width.
 - 4. Joint spacing between pavers shall be between 1/16 to 5/32 inches.
 - 5. Joints between pavers shall be sand filled. Sand shall be a well graded, washed, non-plastic angular material free from foreign matter. Maximum particle size shall be no larger than the joint spacing.
 - 6. Pavers shall be crack-free and consist of full, completely formed domes.
 - 7. A 6 inch concrete edge restraint shall be provided around the full perimeter of the pavers. Concrete shall be cast-in-place, 3000 psi concrete.
 - 8. Pavers shall be protected during construction to avoid damage. Paver surfaces shall be kept clean of cement.

3.08 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.09 PROTECTION

- A. Immediately after placement, protect concrete under provisions of Division 1 from premature drying, excessive hot or cold temperatures, and mechanical injury.

END OF SECTION

SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Sodding.
 - 2. Seeding
 - 3. Lawn renovation.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.
- C. Qualification Data: For landscape Installer.
- D. Material Test Reports: For existing surface soil and imported topsoil.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.
- D. Preinstallation Conference: Conduct conference at Project site upon request by CM.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.7 SCHEDULING

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Contract Completion.
 - 1. Spring Planting: March 15 until June 15.
 - 2. Fall Planting: August 15 until October 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Sodded turf: 60 days from date of Contract Completion.
 - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
- B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
- C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water lawn at a minimum rate of 1 inch per week.
- D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 1. Mow grass 3 to 4 inches high.
- E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species, as follows:
 1. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 70 percent turf-type tall fescue.
 - b. 20 percent perennial ryegrass (*Lolium perenne*).
 - c. 10 percent Kentucky bluegrass (*Poa pratensis*).

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Turf-type tall fescue, a minimum of three cultivars.

2.3 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
 - 1. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

2.4 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: Class T, with a minimum 99 percent passing through No. 8 sieve and a minimum 75 percent passing through No. 60 sieve.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.5 ORGANIC SOIL AMENDMENTS

- A. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.
- B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 FERTILIZER

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.8 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with soil amendments and fertilizers as recommended in the soils report.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding overspray.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 3/4 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Apply superphosphate fertilizer directly to subgrade before loosening.
 - 2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 - 3. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.

- C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Apply superphosphate fertilizer directly to surface soil before loosening.
 - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
- E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Hydroseeding is not permitted. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow lawn seed at the rate of 6 to 8 lb/1000 sq. ft.
- C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at the rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

- F. Protect seeded areas from hot, dry weather or drying winds by applying straw mulch within 24 hours after completing seeding operations. Soak and scatter uniformly to a depth of 3/16 inch and roll to a smooth surface.

3.5 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across angle of slopes exceeding 1:3.
 - 2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- 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.

3.6 TURF RENOVATION

- A. Renovate existing lawn.
- B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 - 1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
- C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.
- D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.
- E. Mow, dethatch, core aerate, and rake existing lawn.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

- I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.
- J. Sod and protect with straw mulch as required for new lawns.
- K. Water newly planted areas and keep moist until new lawn is established.

3.7 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.8 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
 - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
 - 3. Use installed 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 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow grass to a height of 3 to 4 inches.
 - 2. Do not mow detention basin.
- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.9 SATISFACTORY LAWNS

- A. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- C. Remove erosion-control measures after grass establishment period.

END OF SECTION

SECTION 329300

PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Trees.
 - 2. Shrubs.
 - 3. Ground cover.
 - 4. Plants.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.
- D. Bare-Root Stock: Exterior plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of exterior plant required.
- E. Clump: Where three or more young trees were planted in a group and have grown together as a single tree having three or more main stems or trunks.
- F. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball

shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.

- G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.
- H. Finish Grade: Elevation of finished surface of planting soil.
- I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- J. Multi-Stem: Where three or more main stems arise from the ground from a single root crown or at a point right above the root crown.
- K. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- L. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
- M. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis for standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- D. Material Test Reports: For existing surface soil and imported topsoil.
- E. Planting Schedule: Indicating anticipated planting dates for exterior plants.
- F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.
- G. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for plant growth. State-recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.
- D. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."
- E. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above the ground for trees up to 4-inch caliper size, and 12 inches above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.
- F. Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
- G. Plant Substitutions: All substitutions of plant materials must be approved in writing. Enterprise Green Communities (EGC) requires minimum 50% native or adaptive species, and prohibits use of invasive species. Substitution of plant material must include documentation that proposed substitution does not reduce percentage of native or adaptive plant material required for project and that proposed plant material is non-invasive.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver exterior plants freshly dug.
- B. Do not prune trees and shrubs before delivery except as approved by Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping,

and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery and handling.

- C. Handle planting stock by root ball.
- D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in 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 exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 15 until June 15.
 - 2. Fall Planting: August 15 until October 15.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed according to manufacturer's written instructions and warranty requirements.
- C. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns unless otherwise acceptable to Architect.
 - 1. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.8 WARRANTY

- A. Special Warranty: Installer's standard form in which 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 lack of adequate maintenance, neglect, abuse by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.

- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Replacement of plant material as part of punchlist inspection does not constitute a warranty replacement.
- 2. Warranty Periods from Date of Substantial Completion:
 - a. Trees and Shrubs: One year.
 - b. Ground Cover and Plants: One year.
- 3. Include the following remedial actions as a minimum:
 - a. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
 - b. Replace exterior 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 exterior plant will be required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for replaced plant materials; warranty period equal to original warranty period.

1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service for Trees and Shrubs: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until 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.
- B. Initial Maintenance Service for Ground Cover and Plants: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below.
 - 1. Maintenance Period: Six months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

- A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Provide trees and shrubs of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of trees and shrubs required. Trees and shrubs of a

larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1.
- D. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.
- E. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 SHADE AND FLOWERING TREES

- A. Type 1 Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
 - 1. Provide balled and burlapped trees.
 - 2. Branching Height: One-third to one-half of tree height.
- B. Small Upright Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
 - 1. Stem Form: Single trunk and/or Multi-trunk clump, as indicated.
 - 2. Provide balled and burlapped trees.
- C. Small Spreading Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
 - 1. Stem Form: Single trunk, Multi-stem, and/or Clump, as indicated.
 - 2. Provide balled and burlapped trees.

2.3 DECIDUOUS SHRUBS

- A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.
 - 1. Shrub sizes indicated are sizes after pruning.
 - 2. Provide balled and burlapped, balled and potted, and/or container-grown shrubs.

2.4 BROADLEAF EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

- B. Form and Size: Specimen quality as described, symmetrically shaped broadleaf evergreens.

- 1. Shearing Designation: Semi-sheared or lightly sheared (LS).
- 2. Provide balled and burlapped, and/or container-grown trees.

2.5 GROUND COVER PLANTS

- A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.6 PLANTS

- A. Annuals: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.
- B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, complying with requirements in ANSI Z60.1.

2.7 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.
 - 1. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.

2.8 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Provide lime in form of dolomitic limestone.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Perlite: Horticultural perlite, soil amendment grade.

- D. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
- E. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.9 ORGANIC SOIL AMENDMENTS

- A. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.
- B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.10 FERTILIZER

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.11 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: Triple-ground, shredded hardwood.

2.12 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

2.13 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with soil amendments and fertilizers as recommended in the soils report.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. 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.

3.3 PLANTING BED ESTABLISHMENT

- A. Loosen subgrade of planting beds to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

- a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
2. Spread planting soil mix to a depth of 12 inches in plant beds with shrubs and perennials and to a depth of 18 inches in plant beds with trees. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.
- B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Before planting, restore planting beds if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
 1. Excavate approximately three times as wide as ball diameter for balled and burlapped, and container-grown stock.
 2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
- B. Subsoil removed from excavations may be used as backfill.
- C. Obstructions: Notify Architect 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 Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

3.5 TREE AND SHRUB PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.
- B. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball 1 inch above adjacent finish grades.

1. Remove burlap and wire baskets from tops of root balls and partially 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.
 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- C. Set container-grown stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
1. Carefully remove root ball from container without damaging root ball or plant.
 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- D. Organic Mulching: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of planting pit or trench. Do not place mulch within 3 inches of trunks or stems.

3.6 TREE AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.

3.7 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants as indicated.
- B. Dig holes large enough to allow spreading of roots and backfill with planting soil.
- C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.8 PLANTING BED MULCHING

- A. Mulch backfilled surfaces of planting beds and other areas indicated. Provide mulch ring around trees in lawn areas.
1. Organic Mulch: Apply 3-inch average thickness of organic mulch, and finish level with adjacent finish grades. Do not place mulch against plant stems.

3.9 PLANT MAINTENANCE

- A. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

3.10 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.11 DISPOSAL

- A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 33 11 00

WATER DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provide new water lines from the existing water main to points shown on the plans. This includes, but is not limited to the following:
 - 1. Piping and fittings
 - 2. Fire hydrants
 - 3. Curb boxes and valves
 - 4. Post indicating valves, standard and electrically supervised
 - 5. Post type siamese
 - 6. Tapping sleeves and valves
 - 7. Meter pit and piping
 - 8. Flushing and testing
 - 9. Sterilization
 - 10. All labor, equipment, devices, materials and performing all operations necessary in connection with the combined water system as herein specified and shown, indicated or noted on the drawings and subject to the terms and conditions of the contract.

1.02 RELATED SECTIONS

- A. Section 03 30 00, "Cast-in-Place Concrete"
- B. Section 31 23 33, "Piped Utilities - Basic Methods"

1.03 REFERENCES

- A. Construction and Materials Specifications – City of Columbus (CMSC) 2012 Edition

1.04 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Submit product data, shop drawings, catalog cuts, etc., for pipe, fire hydrants, siamese, detector checks, meters, fittings, valves, and accessories.
- C. Certification from the Contractor stating that hydrostatic tests have been conducted in accordance with Specifications and in the presence of the Project Manager and that the completed pipeline is acceptable in accordance with criteria set forth in Specifications for leakage.
- D. Certification from the Contractor stating that pipelines constructed have been disinfected as specified and are safe for conveying potable water.
- E. Sequence of work in accordance with this Section and Division 1.

PART 2 PRODUCTS

- A. Provide products for Water Distribution in accordance with CMSC Section 800 and the details and notes on the drawings.

PART 3 EXECUTION

- A. Perform work in accordance with CMSC Section 800 and notes on drawings.

END OF SECTION

SECTION 33 30 00

SANITARY SEWERAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary drainage piping, fittings, drop connections, and accessories.
- B. Connection of building sanitary drainage system to municipal sewers.
- C. Manholes.
- D. Permits, inspection fees, tap fees, etc.

1.02 RELATED SECTIONS

- A. Section 31 00 00, "Earthwork"
- B. Section 31 23 33, "Piped Utilities - Basic Methods"
- C. Section 03 30 00, "Cast-in-Place Concrete"

1.03 REFERENCES

- A. ASTM 2321 - Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- B. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- C. ASTM D3212 - Joints for drainage Sewer Plastics Pipes using Flexible Elastomeric Seals.
- D. ANSI/ASTM A74 - Cast Iron Soil Pipe and Fittings.
- E. AWWA C106 - Cast Iron Pressure Pipe.
- F. ASTM C12 - Standard Practice for Installing Vitrified Clay Pipelines.
- G. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- H. ASTM C425 - Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable municipal code for materials and installation of the Work of this Section. In the event of a conflict between the drawings and the code, the code shall govern. No extra charges will be allowed for any changes necessary for code compliance.
- B. Contractor to obtain and pay for all required permits, tap fees, inspection fees, etc., as required by City of Columbus.

1.05 SUBMITTALS

- A. Submit shop drawings under provisions of Division 1.
- B. Submit shop drawings indicating dimensions, and invert elevations of manholes and cleanouts.
- C. Submit product data under provisions of Division 1.
- D. Submit product data for pipe, manholes, castings, and pipe accessories.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Division 1.
- B. Accurately record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities. Provide location, size, and elevation of uncharted utilities.

PART 2 PRODUCTS

- A. Provide products for Sanitary Sewerage in accordance with CMSC Section 900 and notes on drawings.

PART 3 EXECUTION

- A. Perform work in accordance with CMSC Section 900 and notes on drawings.

END OF SECTION

SECTION 33 40 00

STORM DRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Storm drainage piping, fittings, and accessories.
- B. Connection of building and site storm water drainage system to municipal sewers.
- C. Catch basins, curb inlets, manholes, underdrains, and headwalls.
- D. Rock channel protection.
- E. Permits, inspection fees, tap fees, etc.

1.02 RELATED SECTIONS

- A. Section 31 23 33, "Piped Utilities - Basic Methods"
- B. Section 03 30 00, "Cast-in-Place Concrete"
- C. Section 31 00 00, "Earthwork"

1.03 REFERENCES

- A. ASTM A74-87: Specification for Cast Iron Soil Pipe and Fittings.
- B. ANSI/ASTM C76-89: Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- C. ANSI/ASTM C443-85: Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- D. ASTM D1248-89: Polyethylene Plastics Molding and Extrusion Materials.
- E. ASTM D2321-89: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- F. ASTM D-3034-89: Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- G. ASTM D3212-89: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- H. ASTM F405-89: Standard Specification for Corrugated Polyethylene (PE) Tubing and Fittings.
- I. ASTM F794: Standard Specification for Poly(Vinyl Chloride) (PVC), Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

- J. Uni-Bell, Uni-B-9: Recommended Standard Performance Specifications for Poly(Vinyl Chloride) (PVC), Large Diameter Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- K. AASHTO M252: Standard Specification for Corrugated Polyethylene Drainage Tubing, 3 to 10 Inches Diameter.
- L. AASHTO M 294: Standard Specification for Corrugated Polyethylene Pipe, 4 to 60 Inches Diameter.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable City code for materials and installation of the Work of this Section.
- B. Contractor to obtain and pay for all required permits, tap fees, inspection fees, etc., as required by Governing Authority.

1.05 SUBMITTALS

- A. Submit shop drawings under provisions of Division 1.
- B. Submit shop drawings indicating dimensions, and invert elevations of manholes and cleanouts.
- C. Submit product data under provisions of Division 1.
- D. Submit product data for pipe, manholes, castings, and pipe accessories.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Division 1.
- B. Accurately record location of pipe runs, connections, catch basins, manholes, cleanouts, and invert elevations if different than shown on plans.
- C. Identify and describe unexpected variations to subsoil condition or discovery of uncharted utilities.

PART 2 PRODUCTS

- A. Provide products for Storm Drainage in accordance with CMSC Items 603, 604 and 605 and detail references and notes on drawings.

PART 3 EXECUTION

- A. Perform work in accordance with CMSC Items 603, 604 and 605 and notes on drawings.

END OF SECTION

July 23, 2021

Mr. Anup Janardhanan, AIA, NCARB,
Associate Principal
Moody Nolan
300 Spruce Street, Suite 300
Columbus, OH 43215

**RE: HUD Noise Assessment
Harriet's Hope Residential Development
Columbus, Ohio**

Dear Mr. Janardhanan:

We performed a noise assessment of the subject property using the United States Department of Housing and Urban Development (HUD) Noise Assessment Guidelines. The assessment evaluates the site's exposure to three major sources of noise — aircraft, roadways, and railways to assign with an acceptability category based on HUD regulations. Our findings are presented below.

Executive Summary

This project consists of a multi-family residential development with approximately 52 one and two-bedroom units. The project will be funded by the Columbus Metropolitan Housing Authority (CMHA), which requires a HUD Noise Assessment be performed. The Noise Assessment studies the noise impacts from aircraft, railway, and roadway sources on the project and the environment for the future occupants. The airports within 15 miles of the site are Rickenbacker International Airport, Port Columbus International Airport, Bolton Field, and the Ohio State University Airport, and are required to be studied. There are two railways operated by CSX Transportation Great Lakes Columbus line and Indiana & Ohio Railroad Northern Midland line within 3,000 ft of the project site, to be studied. There is one major roadway to be studied within 1,000 ft of the project site, Interstate 70. Collectively, we find that the combined noise impacts from the aircraft and railway sources do not have any noise impact to the site. The predicted noise from Interstate 70 is considered "Normally Unacceptable" without sound attenuation and can be "Acceptable with Upgrades" for residential development. Sound attenuation is required for the North, South, and West facades of the building. To be considered "Acceptable" by HUD's criteria, there must be 5 to 10 decibels of additional attenuation (see Table 2) included for the exterior façade construction, to maintain an interior noise level below DNL 45. Acoustical performance ratings for suitable windows that will achieve the necessary mitigation are provided.

Project Understanding

This project consists of a new residential building to be located at 1567-1579 West Broad Street in Columbus, Ohio (see Figure 1 below). Funding for the project from CMHA requires a HUD Noise Assessment be performed to determine if the site is acceptable for residential development, whether noise mitigation is required, or whether this site is not suitable for residential development.





Figure 1: Location of project site, outlined in yellow, with an overlay of the project building. The project is also referred to as Noise Assessment Location (NAL) by the HUD Noise Guidebook.

HUD NOISE STANDARDS

The HUD Noise Assessment Guidebook outlines the process for determining the suitability of site for HUD funded residential developments. The next sections will discuss the process and requirements for the assessment.

EXTERIOR NOISE STANDARDS

To assess the exterior sound levels, the HUD Noise Assessment methodology uses the Day-Night Average Sound Level, DNL, for assessing the noise exposure at a site. The DNL is calculated as the average sound level during the daytime (7 am to 10 pm), averaged with the nighttime average sound level with a 10 dB increase to represent the sensitivity of residents who may be sleeping during the period between 10 pm and 7 am. The HUD methodology establishes the numerous factors that are accounted for with each sound source. The DNL values for each of the sources (airports, roadways, and railways) are added together to arrive at the exterior noise exposure to the project site.

HUD regulations established the following exterior noise categories for assessing the suitability a site for new housing projects. These categories are summarized in Table 1 below.

TABLE 1. HUD EXTERIOR NOISE STANDARDS & REQUIREMENTS		
Exterior Day-Night Average Sound Level (DNL)	Acceptability Category	Requirement
DNL 65 or less	Project considered Normally Acceptable.	Noise mitigation not required.
$65 < \text{DNL} \leq 70$	Project considered Normally Unacceptable.	Noise mitigation providing an additional 5 dBA attenuation is required for the project.
$70 < \text{DNL} \leq 75$	Project considered Normally Unacceptable.	Noise mitigation providing an additional 10 dBA attenuation is required for the project.
$\text{DNL} > 75$	Project considered Unacceptable.	Special approvals are necessary for development.

INTERIOR NOISE STANDARDS

HUD Noise Regulation also sets the interior sound level goal such that a day-night equivalent sound level DNL of 45 shall not be exceeded within the project's interior spaces. This goal is used for assessing the mitigation options. To achieve this HUD interior sound level goal, the sound attenuation required for the project's building envelope, such as the exterior window systems, the exterior walls, etc., should be determined based on the exterior day-night equivalent sound level that is calculated from the aircraft, roadway, and/or railway sources around the project site.

Site Exterior Sound Level Assessment

The HUD Noise Assessment requires the evaluation of noise from:

- Civil and Military Airports within 15 miles,
- Railways within 3,000 ft, and
- Major roadways within 1,000 ft. and at least 10,000 AADT.

For the Harriet's Hope site, the noise to the building site from each mode of transportation is described and evaluated below.

AIRCRAFT NOISE ASSESSMENT

The HUD Noise Assessment Guideline, states that all civil and military airports located within 15 miles of the project site must be included in the noise assessment. The closest airports to the subject property are located within the distance criteria specified by HUD. They are:

- Rickenbacker International Airport (Civil), located approximately 11 miles from the site boundary
- Port Columbus International Airport (Civil), located approximately 8 miles from the site boundary
- Bolton Field (Civil), located approximately 6 miles from the site boundary, and
- Ohio State University Airport (Civil), located approximately 8.5 miles from the site boundary.

The 15-mile radius from the site and the airports within that circle are shown in Figure 2 below.

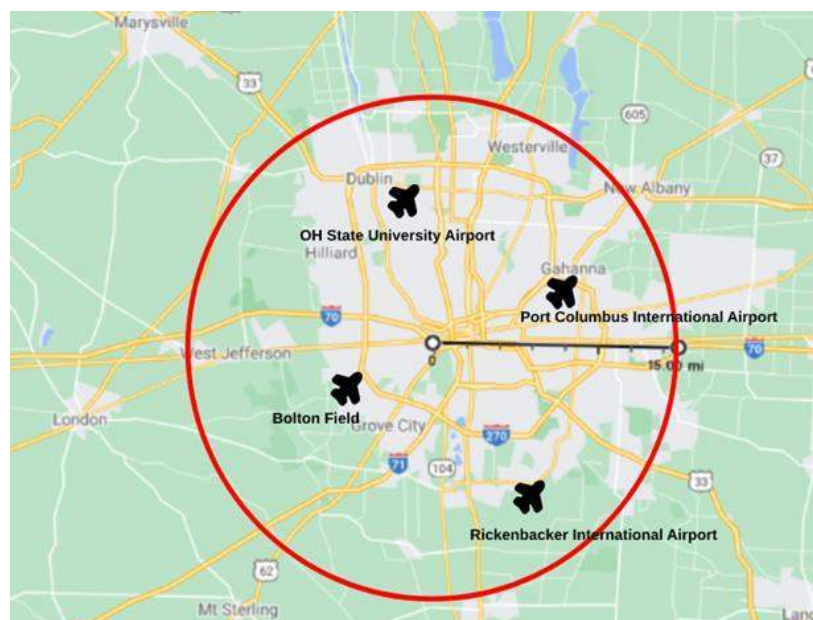


Figure 2. Airports within 15 miles (red circle) of the proposed project site

We noted that there were two additional private airports within the 15 miles, Darby Dan Airport and Lytle Airport, though these airfields appear to be closed and therefore were not included in this analysis.

We located noise contour maps for each airport to perform this assessment. We note that many are based on studies of older operations at these facilities. Based on these noise contours, we estimate that the total noise exposure from all the airports to the project site is DNL 42. This documents that aircraft noise is not a major contributor to the transit noise experience at the project site.

RAILWAY NOISE ASSESSMENT

The HUD Noise Assessment Guideline states that all rail lines located within 3,000 feet of the project site must be included in the Noise Assessment. We determined that the CSX Transportation Great Lakes Columbus line and Indiana & Ohio Railroad (IORY) Northern Midland line are within 3,000 feet of the project site and are required to be studied. The 3,000-foot radius and rail lines are shown in Figure 3 below.

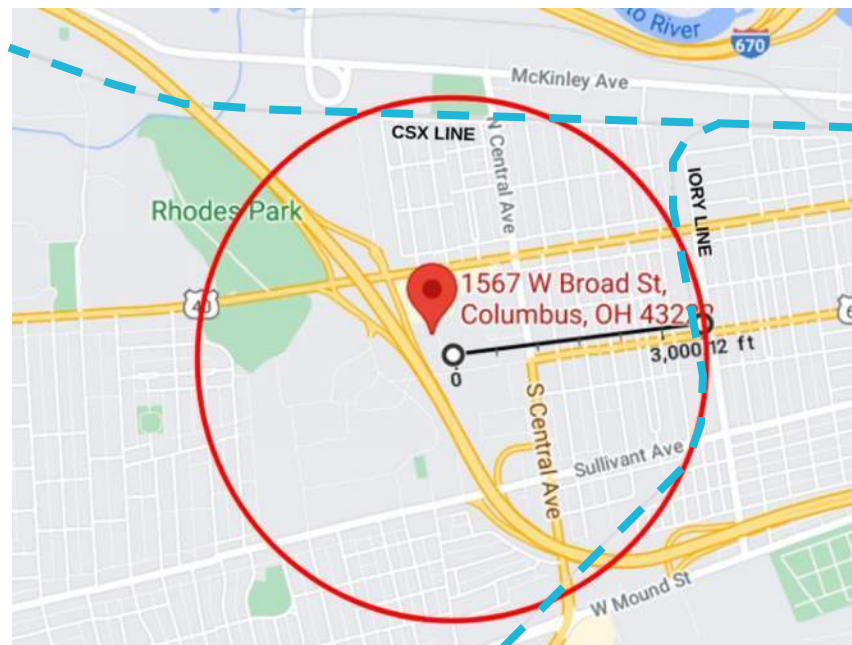


Figure 3: Railways (dashed blue lines) within 1,000 Feet (red circle) of Project Site.

We located the railway activity data for the two nearest crossings on the Federal Railroad Administration (FRA) US. DOT Crossing Inventory Forms for these two railroads (see attached). Based on these data, we predict that the noise level at the building site may be as high as DNL 49 exposed to the north, east and south elevations. This finding confirms that the railroad noise at this site will have no impact to the residential development.

ROADWAY NOISE ASSESSMENT

The HUD Noise Assessment Guidelines state that all major roads located within 1,000 feet of the project site must be included in the Noise Assessment. This is understood to refer to roadways that are numbered by the State or Federal governments, and to roadways with more than 10,000 annual average daily traffic (AADT) counts.

Based on those criteria, we identified two roads to be assessed for their potential noise impacts. Figure 4 below shows that Interstate 70 and Central Avenue are within 1,000 feet of the site. We note that Route 40, north of the site, is just beyond the 1,000-foot distance, and therefore was not studied for this assessment.

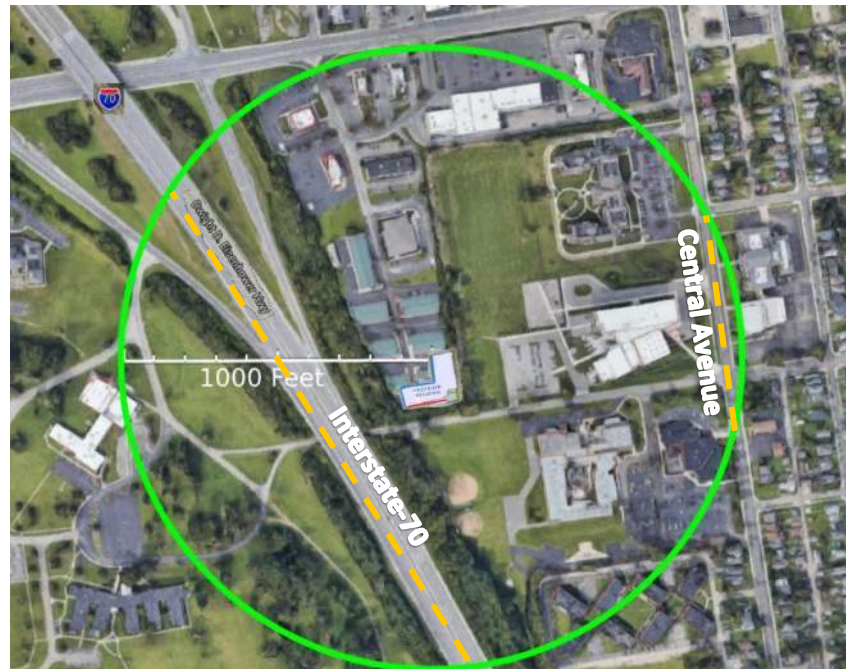


Figure 4: Roadways (dashed yellow lines) within 1,000 Feet (green circle) of Project Site.

We reviewed a traffic study specifically for this project by Ohio Department of Transportation (ODOT) with actual traffic count data at the site for a period of 24 hours. These traffic counts are attached to this report. The vehicle traffic counts for Interstate 70 (67,560) and Central Avenue (12,407) are above the 10,000 AADT. Based on this, both roads are required to be studied for this assessment.

From our assessment, we have determined the individual and combined sound levels from each of these roads. We predict that the noise exposed to the west side of the building is DNL 74, while the exposure to the north side is DNL 69, south side is DNL 71, and east side is DNL 60.

The largest contributor of roadway noise to the project site is from the vehicles traveling on Interstate 70. This noise level is above the DNL 65 requirement and will require that the building enclosure provides additional sound attenuation as stated by HUD requirements.

Site DNL and Acceptability Category Results

For the proposed Harriet’s Hope project, we calculated the HUD Noise Assessment total DNL levels along each façade. Due to the “L” shape of the building, we divided several of the façade elevations into two parts, with two different levels of sound exposure due to differences in distances from and their exposure to the noise sources. This includes the North, West and South facades, which each have two parts that were studied. These different parts of the façade are shown and labeled in Figure 5 below.

At the West, North, and South elevations of the proposed residential building, the predictions of the combined transit noise document at the building exceeded the DNL 65 sound level and are considered “Normally Unacceptable”, but can be acceptable with mitigation. The results for the East façade indicate

that this façade is exposed to levels that are Acceptable. The results are numerically summarized in Table 2 below, while Figure 5 graphically highlights these facades with orange, yellow and green to represent these DNL noise exposures.



Figure 5: Building Facade DNL levels with Orange for DNL >70 to 75, Yellow for DNL >65 to 70, both considered “Normally Unacceptable”, and Green for DNL 65 or less, considered “Acceptable”.

The predictions for each façade show that the DNL of the site is most significantly impacted by the vehicle noise from Interstate 70. This HUD Acceptability finding results in this need to analyze the exterior construction details to determine if sufficient noise attenuation is provided by or needs to be designed for to mitigate the transit noise experience from the nearby interstate road. If sufficient noise attenuation is provided, this site can potentially be “acceptable with upgrades” if enough protection from the I-70 traffic noise is provided for the proposed residential building. The details of these cumulative sound levels are presented in the attached Worksheet A.

TABLE 2. Façade DNL and Acceptability Category Results			
Elevation	Day-Night Average Sound Level (dB)	Acceptability Category	Mitigation
West A	DNL 74	Normally Unacceptable	10 dBA Additional Attenuation
West B	DNL 71	Normally Unacceptable	10 dBA Additional Attenuation
North A	DNL 71	Normally Unacceptable	10 dBA Additional Attenuation
North B	DNL 69	Normally Unacceptable	5 dBA Additional Attenuation
South A	DNL 71	Normally Unacceptable	10 dBA Additional Attenuation
South B	DNL 67	Normally Unacceptable	5 dBA Additional Attenuation
East	DNL 60	Normally Acceptable	No Additional Attenuation

Exterior Wall/Window Design Analysis

Based on the calculated noise exposures, the North, West, and South façades of the proposed building will require upgrades that provide between 5 and 10 dB of additional noise attenuation to achieve the interior DNL 45 sound level require by HUD. To provide enough attenuation to meet this interior DNL 45 level, we are setting a performance goal of OITC 29 for the composite exterior wall assembly.

We studied the sound isolation provided by the building envelope(s) to confirm the design(s) achieves the HUD interior ambient sound level requirement of DNL 45 dB or lower within the occupied spaces given the predicted noise exposure for each façade.

Since the building envelope consists of an exterior wall assembly with windows, our acoustical analysis of the components of the envelope and recommendations for product performance are below.

EXTERIOR WALL ASSEMBLY

As shown on Sheets A5.1 and A5.2 *Typical Wall Sections*, we understand that the proposed solid exterior wall constructions will comprise the following components:

- Brick veneer with 2-inch air gap or vertical board and batten vinyl siding,
- Continuous air barrier,
- One (1) layer of 5/8-inch exterior sheathing,
- 2x6-inch wood framing with batt insulation between studs,
- One (1) layer of 5/8-inch Type X GWB

We anticipate that this solid exterior wall without any windows or openings will achieve a sound isolation performance rating of approximately Outdoor-Indoor Transmission Class (OITC) 40 where brick veneer is planned, and OITC 31 where vinyl siding is planned. Without windows or other penetrations, either of these exterior wall types will provide sufficient noise isolation from the predicted transit noise for each of the façades, such as for North B and South B.

WINDOWS

Based on the acoustic performance of the exterior wall assembly, the windows are able to perform at a slightly lower level of sound isolation to create a composite wall assembly that achieves the OITC 29 goal. For the Eastern façade of the building, there is no OITC performance goal to be met, as there is no additional mitigation needed.

For the other façades, we estimated the necessary acoustical performance of the windows in the exterior wall assembly. Using the approximate window sizes that are planned, we estimate that the **windows for the West A & B, North A and South A facing sides of the building that achieves a minimum OITC 27**

rating. It might be useful to note that even if the window sizes change by up to +/- 25%, this OITC rating is still suitable.

The required OITC ratings should be available from the various window manufacturers for the window systems that they offer. The ratings will be based on a suitably airtight frame system and glazing that is selected. An example of a glazing composition that achieves this rating is provided below:

OITC 27 window system: 1-inch insulated glazing unit comprising a 1/4-inch annealed exterior pane and a 1/4-inch annealed interior pane, separated by a 1/2-inch airspace.

Note that we have assumed that the windows will be closed with mechanical ventilation for the residences. If residents choose to open their windows, they will be deciding to reduce the noise mitigation that they are provided and allow excess noise into their residence.

The composite exterior wall and window assembly described above achieves sufficient isolation from the transportation noise, to meet an interior sound level of DNL 45 or lower.

We trust this provides the information that you need at this time. Please feel free to contact us by email (Jeffrey.Fullerton@intertek.com or William.Macgavin@intertek.com) or phone (857-523-6576 or 717-487-5949) should you have any questions or require further information.

Sincerely,

Architectural Testing, Inc., an Intertek company



Digitally signed by Jeffrey Fullerton
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Acoustics Department Manager
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William MacGavin
Project Specialist
Building Science Solutions

WM/JF:mds

Enclosures: HUD Noise Assessment Worksheets A, B, C, D for North A, North B, West A, West B,
South A, South B, East (16 pages)
Airport Noise Contours (4 pages)
Indiana and Ohio Railroad Inventory Report (2 pages)
CSX Transportation Railroad Inventory Report (2 pages)
ODOT Traffic Count Study (3 pages)

Worksheet A - Site Evaluation

Site Location: 1567-1578 West Broad Street, Columbus, OH Program: Project Name: Harriet's Hope Locality: File Number: Sponsor's Name: Phone Number: Street Address: City/State:

		Acceptability	DNL	Predicted for Operations in Year
1	Aircraft Noise	Normally Acceptable	42	2001, 2006, 2007, 2018
2	Roadway Noise	Acceptable with Upgrades (10 dB)	74	2010, 2013
3	Railway Noise	Normally Acceptable	49	2020

DNL for All Noise Sources at West A Elevation	74

Final Site Evaluation for West Elevation

Acceptable with Upgrades (10 dB)

Worksheet A - Site Evaluation

Site Location: 1567-1578 West Broad Street, Columbus, OH
Program:
Project Name: Harriet's Hope
Locality:
File Number:
Sponsor's Name:
Phone Number:
Street Address:
City/State:

		Acceptability	DNL	Predicted for Operations in Year
1	Aircraft Noise	Normally Acceptable	42	2001, 2006, 2007, 2018
2	Roadway Noise	Acceptable with Upgrades (10 dB)	71	2010, 2013
3	Railway Noise	Normally Acceptable	49	2020

DNL for All Noise Sources at West B Elevation	71

Final Site Evaluation for West Elevation

Acceptable with Upgrades (10 dB)

Worksheet A - Site Evaluation

Site Location: 1567-1578 West Broad Street, Columbus, OH
Program:
Project Name: Harriet's Hope
Locality:
File Number:
Sponsor's Name:
Phone Number:
Street Address:
City/State:

		Acceptability	DNL	Predicted for Operations in Year
1	Aircraft Noise	Normally Acceptable	42	2001, 2006, 2007, 2018
2	Roadway Noise	Acceptable with Upgrades (10 dB)	71	2010, 2013
3	Railway Noise	Normally Acceptable	49	2020

DNL for All Noise Sources at North A Elevation	71

Final Site Evaluation for North Elevation

Acceptable with Upgrades (10 dB)

Worksheet A - Site Evaluation

Site Location: 1567-1578 West Broad Street, Columbus, OH Program: Project Name: Harriet's Hope Locality: File Number: Sponsor's Name: Phone Number: Street Address: City/State:

		Acceptability	DNL	Predicted for Operations in Year
1	Aircraft Noise	Normally Acceptable	42	2001, 2006, 2007, 2018
2	Roadway Noise	Acceptable with Upgrades (5 dB)	69	2010, 2013
3	Railway Noise	Normally Acceptable	49	2020

DNL for All Noise Sources at North B Elevation	69

Final Site Evaluation for North Elevation

Acceptable with Upgrades (5 dB)

Worksheet A - Site Evaluation

Site Location: 1567-1578 West Broad Street, Columbus, OH
Program:
Project Name: Harriet's Hope
Locality:
File Number:
Sponsor's Name:
Phone Number:
Street Address:
City/State:

		Acceptability	DNL	Predicted for Operations in Year
1	Aircraft Noise	Normally Acceptable	42	2001, 2006, 2007, 2018
2	Roadway Noise	Acceptable with Upgrades (10 dB)	71	2010, 2013
3	Railway Noise	Normally Acceptable	49	2020

DNL for All Noise Sources at South A Elevation	71

Final Site Evaluation for South Elevation

Acceptable with Upgrades (10 dB)

Worksheet A - Site Evaluation

Site Location: 1567-1578 West Broad Street, Columbus, OH Program: Project Name: Harriet's Hope Locality: File Number: Sponsor's Name: Phone Number: Street Address: City/State:

		Acceptability	DNL	Predicted for Operations in Year
1	Aircraft Noise	Normally Acceptable	42	2001, 2006, 2007, 2018
2	Roadway Noise	Acceptable with Upgrades (5 dB)	67	2010, 2013
3	Railway Noise	Normally Acceptable	49	2020

DNL for All Noise Sources at South B Elevation	67

Final Site Evaluation for South Elevation

Acceptable with Upgrades (5 dB)

Worksheet A - Site Evaluation

Site Location: 1567-1578 West Broad Street, Columbus, OH Program: Project Name: Harriet's Hope Locality: File Number: Sponsor's Name: Phone Number: Street Address: City/State:

		Acceptability	DNL	Predicted for Operations in Year
1	Aircraft Noise	Normally Acceptable	42	2001, 2006, 2007, 2018
2	Roadway Noise	Normally Acceptable	60	2010, 2013
3	Railway Noise	Normally Acceptable	49	2020

DNL for All Noise Sources at East Elevation	61

Final Site Evaluation for East Elevation

Normally Acceptable

Worksheet B - Aircraft Noise Assessment

Include All Airports within 15 miles of the site

Airport #1: **Rickenbacker IA**
 Airport #2: **Port Columbus IA**
 Airport #3: **OH State Uni Airport**
 Airport #4: **Bolton Field**
 Airport #5:

	Rickenbacker IA	Port Columbus IA	OH State Uni Airport	Bolton Field	
1 Are DNL, NEF or CNR contours available?	☒ Contour Available?	☒ Contour Available?	☒ Contour Available?	☒ Contour Available?	☐ Contour Available?
2 Any supersonic aircraft operations?	☐ Supersonic Aircraft?	☐ Supersonic Aircraft?	☐ Supersonic Aircraft?	☐ Supersonic Aircraft?	☐ Supersonic Aircraft?
3 Estimating approximate contours from Figure 3	Skip to Question #4	Skip to Question #4	Skip to Question #4	Skip to Question #4	
a Number of nighttime jet operations					
b Number of daytime jet operations					
c Effective number of operations	0	0	0	0	0
d Distance A for 65 dB					
70 dB					
75 dB					
e Distance B for 65 dB					
70 dB					
75 dB					
4 Estimating DNL from Table 2					
a Distance from 65 dB Contour to flight path D1	1,300	2,000	1,000	1,200	
b Distance from NAL to flight path D2	35,000	55,000	45,000	30,000	
c D2 divided by D1	27	28	60	25	
d DNL	36	36	29	37	
5 Operations projected for what year?					
6 Total DNL from all airports	42				

Worksheet C Roadway Noise Assessment - West A Elevation

Include All Roadways within 1,000 ft of the site

Roadway #1: **Interstate 70 (2 Way)**

Roadway #2: **Central Ave (SB)**

Roadway #3: **Central Ave (NB)**

Roadway #4:

		Interstate 70 (2 Way)	Central Ave (SB)	Central Ave (NB)	
1	Distance in feet from the NAL to the edge of the road				
a	Nearest Lane	200	955	985	
b	Farthest Lane	300	985	1005	
c	Average (effective distance)	250	970	995	#DIV/0!
2	Distance to Stop Sign (do not include traffic lights)	1000	1000	1000	
3	Road gradient (in percent)	0.8	0.4	0.4	
4	Average Speed (in mph)				
a	Automobiles	70	40	40	
b	Heavy trucks - uphill	70	40	40	
c	Heavy trucks - downhill	70	40	40	
5	24 Hr average number of automobiles and medium trucks in both directions (ADT)				
	Total AADT	67,560	5,337	7,070	
a	Automobiles 85%	57,426	4,536	6,010	0
b	Medium Trucks 10%	6,756	534	707	0
c	Effective ADT	124,986	9,873	13,080	0
6	24 hour average number of heavy trucks				
a	Uphill	1,689	133	177	0
b	Downhill	1,689	133	177	0
c	Total 5%	3,378	267	354	0
7	Fraction of Nighttime Traffic (10pm to 7am)	0.15	0.15	0.15	0.15
8	Traffic projected for what year?	2010	2017	2017	
Automobiles					
9	Stop-and-Go (Table 3)	1.00	1.00	1.00	0.10
10	Average Speed (Table 4) x	1.62	0.53	0.53	0.00
11	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
12	Auto ADT x	124,986	9,873	13,080	0
13	Adjusted Auto ADT =	202,457	5,222	6,918	0
	Lookup information	202457 Ops. & 250 ft	5222 Ops. & 970 ft	6918 Ops. & 995 ft	#DIV/0!
14	DNL (Workchart 1) (lookup)	71	50	49	
15	Barrier Attenuation (est.)	0	-15	-15	
16	Partial DNL	71	35	34	0
Heavy Trucks					
17	Gradient Uphill	1.0	1.0	1.0	1.0
	-				
18	Average Speed (Table 7) Uphill	1.60	0.81	0.81	0.81
	Downhill	1.60	0.81	0.81	0.81
19	Truck ADT/2 Uphill	1,689	133	177	0
	Downhill	1,689	133	177	0
20	Up/down ADT Uphill	2,697	108	143	0
	Downhill	2,697	108	143	0
21	Combined ADT	5,394	216	286	0
22	Stop-and-Go (Table 8) x	1.0	1.0	1.0	1.8
23	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
24	Adjusted Truck ADT =	5,394	216	286	0
	Lookup information	5394 Ops. & 250 ft	216 Ops. & 970 ft	286 Ops. & 995 ft	#DIV/0!
25	DNL (Workchart 2) (lookup)	71	48	48	
26	Barrier Attenuation (est.)	0	-15	-15	0
27	Partial DNL	71	33	33	0
Combined Autos and Heavy Trucks					
	Combined Autos & Heavy Trucks DNL	74	37	37	3
	Total All Roadways		74		

Worksheet C Roadway Noise Assessment - West B Elevation

Include All Roadways within 1,000 ft of the site

Roadway #1: **Interstate 70 (2 Way)**

Roadway #2: **Central Ave (SB)**

Roadway #3: **Central Ave (NB)**

Roadway #4:

		Interstate 70 (2 Way)	Central Ave (SB)	Central Ave (NB)	
1	Distance in feet from the NAL to the edge of the road				
a	Nearest Lane	210	915	940	
b	Farthest Lane	310	940	950	
c	Average (effective distance)	260	927.5	945	#DIV/0!
2	Distance to Stop Sign (do not include traffic lights)	1000	1000	1000	
3	Road gradient (in percent)	0.8	0.4	0.4	
4	Average Speed (in mph)				
a	Automobiles	70	40	40	
b	Heavy trucks - uphill	70	40	40	
c	Heavy trucks - downhill	70	40	40	
5	24 Hr average number of automobiles and medium trucks in both directions (ADT)				
	Total AADT	67,560	5,337	7,070	
a	Automobiles 85%	57,426	4,536	6,010	0
b	Medium Trucks 10%	6,756	534	707	0
c	Effective ADT	124,986	9,873	13,080	0
6	24 hour average number of heavy trucks				
a	Uphill	1,689	133	177	0
b	Downhill	1,689	133	177	0
c	Total 5%	3,378	267	354	0
7	Fraction of Nighttime Traffic (10pm to 7am)	0.15	0.15	0.15	0.15
8	Traffic projected for what year?	2010	2017	2017	
Automobiles					
9	Stop-and-Go (Table 3)	1.00	1.00	1.00	0.10
10	Average Speed (Table 4) x	1.62	0.53	0.53	0.00
11	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
12	Auto ADT x	124,986	9,873	13,080	0
13	Adjusted Auto ADT =	202,457	5,222	6,918	0
	Lookup information	202457 Ops. & 260 ft	5222 Ops. & 927.5 ft	6918 Ops. & 945 ft	#DIV/0!
14	DNL (Workchart 1) (lookup)	71	50	49	
15	Barrier Attenuation (est.)	-3	-10	-10	0
16	Partial DNL	68	40	39	0
Heavy Trucks					
17	Gradient Uphill	1.0	1.0	1.0	1.0
	-				
18	Average Speed (Table 7) Uphill	1.60	0.81	0.81	0.81
	Downhill	1.60	0.81	0.81	0.81
19	Truck ADT/2 Uphill	1,689	133	177	0
	Downhill	1,689	133	177	0
20	Up/down ADT Uphill	2,697	108	143	0
	Downhill	2,697	108	143	0
21	Combined ADT	5,394	216	286	0
22	Stop-and-Go (Table 8) x	1.0	1.0	1.0	1.8
23	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
24	Adjusted Truck ADT =	5,394	216	286	0
	Lookup information	5394 Ops. & 260 ft	216 Ops. & 927.5 ft	286 Ops. & 945 ft	#DIV/0!
25	DNL (Workchart 2) (lookup)	71	48	48	
26	Barrier Attenuation (est.)	-3	-10	-10	0
27	Partial DNL	68	38	38	0
Combined Autos and Heavy Trucks					
	Combined Autos & Heavy Trucks DNL	71	42	42	3
	Total All Roadways		71		

Worksheet C Roadway Noise Assessment - North A Elevation

Include All Roadways within 1,000 ft of the site

Roadway #1: **Interstate 70 (2 Way)**

Roadway #2: **Central Ave (SB)**

Roadway #3: **Central Ave (NB)**

Roadway #4:

		Interstate 70 (2 Way)	Central Ave (SB)	Central Ave (NB)	
1	Distance in feet from the NAL to the edge of the road				
a	Nearest Lane	210	915	940	
b	Farthest Lane	310	940	950	
c	Average (effective distance)	260	927.5	945	#DIV/0!
2	Distance to Stop Sign (do not include traffic lights)	1000	1000	1000	
3	Road gradient (in percent)	0.8	0.4	0.4	
4	Average Speed (in mph)				
a	Automobiles	70	40	40	
b	Heavy trucks - uphill	70	40	40	
c	Heavy trucks - downhill	70	40	40	
5	24 Hr average number of automobiles and medium trucks in both directions (ADT)				
	Total AADT	67,560	5,337	7,070	
a	Automobiles 85%	57,426	4,536	6,010	0
b	Medium Trucks 10%	6,756	534	707	0
c	Effective ADT	124,986	9,873	13,080	0
6	24 hour average number of heavy trucks				
a	Uphill	1,689	133	177	0
b	Downhill	1,689	133	177	0
c	Total 5%	3,378	267	354	0
7	Fraction of Nighttime Traffic (10pm to 7am)	0.15	0.15	0.15	0.15
8	Traffic projected for what year?	2010	2017	2017	
Automobiles					
9	Stop-and-Go (Table 3)	1.00	1.00	1.00	0.10
10	Average Speed (Table 4) x	1.62	0.53	0.53	0.00
11	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
12	Auto ADT x	124,986	9,873	13,080	0
13	Adjusted Auto ADT =	202,457	5,222	6,918	0
	Lookup information	202457 Ops. & 260 ft	5222 Ops. & 927.5 ft	6918 Ops. & 945 ft	#DIV/0!
14	DNL (Workchart 1) (lookup)	71	50	49	
15	Barrier Attenuation (est.)	-3	-10	-10	0
16	Partial DNL	68	40	39	0
Heavy Trucks					
17	Gradient Uphill	1.0	1.0	1.0	1.0
	-				
18	Average Speed (Table 7) Uphill	1.60	0.81	0.81	0.81
	Downhill	1.60	0.81	0.81	0.81
19	Truck ADT/2 Uphill	1,689	133	177	0
	Downhill	1,689	133	177	0
20	Up/down ADT Uphill	2,697	108	143	0
	Downhill	2,697	108	143	0
21	Combined ADT	5,394	216	286	0
22	Stop-and-Go (Table 8) x	1.0	1.0	1.0	1.8
23	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
24	Adjusted Truck ADT =	5,394	216	286	0
	Lookup information	5394 Ops. & 260 ft	216 Ops. & 927.5 ft	286 Ops. & 945 ft	#DIV/0!
25	DNL (Workchart 2) (lookup)	71	48	48	
26	Barrier Attenuation (est.)	-3	-10	-10	0
27	Partial DNL	68	38	38	0
Combined Autos and Heavy Trucks					
	Combined Autos & Heavy Trucks DNL	71	42	42	3
	Total All Roadways		71		

Worksheet C Roadway Noise Assessment - North B Elevation

Include All Roadways within 1,000 ft of the site

Roadway #1: **Interstate 70 (2 Way)**

Roadway #2: **Central Ave (SB)**

Roadway #3: **Central Ave (NB)**

Roadway #4:

		Interstate 70 (2 Way)	Central Ave (SB)	Central Ave (NB)	
1	Distance in feet from the NAL to the edge of the road				
a	Nearest Lane	290	915	940	
b	Farthest Lane	390	940	955	
c	Average (effective distance)	340	927.5	947.5	#DIV/0!
2	Distance to Stop Sign (do not include traffic lights)	1000	1000	1000	
3	Road gradient (in percent)	0.8	0.4	0.4	
4	Average Speed (in mph)				
a	Automobiles	70	40	40	
b	Heavy trucks - uphill	70	40	40	
c	Heavy trucks - downhill	70	40	40	
5	24 Hr average number of automobiles and medium trucks in both directions (ADT)				
	Total AADT	67,560	5,337	7,070	
a	Automobiles 85%	57,426	4,536	6,010	0
b	Medium Trucks 10%	6,756	534	707	0
c	Effective ADT	124,986	9,873	13,080	0
6	24 hour average number of heavy trucks				
a	Uphill	1,689	133	177	0
b	Downhill	1,689	133	177	0
c	Total 5%	3,378	267	354	0
7	Fraction of Nighttime Traffic (10pm to 7am)	0.15	0.15	0.15	0.15
8	Traffic projected for what year?	2010	2017	2017	
Automobiles					
9	Stop-and-Go (Table 3)	1.00	1.00	1.00	0.10
10	Average Speed (Table 4) x	1.62	0.53	0.53	0.00
11	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
12	Auto ADT x	124,986	9,873	13,080	0
13	Adjusted Auto ADT =	202,457	5,222	6,918	0
	Lookup information	202457 Ops. & 340 ft	5222 Ops. & 927.5 ft	6918 Ops. & 947.5 ft	#DIV/0!
14	DNL (Workchart 1) (lookup)	69	50	49	
15	Barrier Attenuation (est.)	-3	-3	-3	0
16	Partial DNL	66	47	46	0
Heavy Trucks					
17	Gradient Uphill	1.0	1.0	1.0	1.0
	-				
18	Average Speed (Table 7) Uphill	1.60	0.81	0.81	0.81
	Downhill	1.60	0.81	0.81	0.81
19	Truck ADT/2 Uphill	1,689	133	177	0
	Downhill	1,689	133	177	0
20	Up/down ADT Uphill	2,697	108	143	0
	Downhill	2,697	108	143	0
21	Combined ADT	5,394	216	286	0
22	Stop-and-Go (Table 8) x	1.0	1.0	1.0	1.8
23	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
24	Adjusted Truck ADT =	5,394	216	286	0
	Lookup information	5394 Ops. & 340 ft	216 Ops. & 927.5 ft	286 Ops. & 947.5 ft	#DIV/0!
25	DNL (Workchart 2) (lookup)	69	48	48	
26	Barrier Attenuation (est.)	-3	-3	-3	0
27	Partial DNL	66	45	45	0
Combined Autos and Heavy Trucks					
	Combined Autos & Heavy Trucks DNL	69	49	49	3
	Total All Roadways		69		

Worksheet C Roadway Noise Assessment - South A Elevation

Include All Roadways within 1,000 ft of the site

Roadway #1: **Interstate 70 (2 Way)**

Roadway #2: **Central Ave (SB)**

Roadway #3: **Central Ave (NB)**

Roadway #4:

		Interstate 70 (2 Way)	Central Ave (SB)	Central Ave (NB)	
1	Distance in feet from the NAL to the edge of the road				
a	Nearest Lane	210	915	940	
b	Farthest Lane	310	940	950	
c	Average (effective distance)	260	927.5	945	#DIV/0!
2	Distance to Stop Sign (do not include traffic lights)	1000	1000	1000	
3	Road gradient (in percent)	0.8	0.4	0.4	
4	Average Speed (in mph)				
a	Automobiles	70	40	40	
b	Heavy trucks - uphill	70	40	40	
c	Heavy trucks - downhill	70	40	40	
5	24 Hr average number of automobiles and medium trucks in both directions (ADT)				
	Total AADT	67,560	5,337	7,070	
a	Automobiles 85%	57,426	4,536	6,010	0
b	Medium Trucks 10%	6,756	534	707	0
c	Effective ADT	124,986	9,873	13,080	0
6	24 hour average number of heavy trucks				
a	Uphill	1,689	133	177	0
b	Downhill	1,689	133	177	0
c	Total 5%	3,378	267	354	0
7	Fraction of Nighttime Traffic (10pm to 7am)	0.15	0.15	0.15	0.15
8	Traffic projected for what year?	2010	2017	2017	
Automobiles					
9	Stop-and-Go (Table 3)	1.00	1.00	1.00	0.10
10	Average Speed (Table 4) x	1.62	0.53	0.53	0.00
11	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
12	Auto ADT x	124,986	9,873	13,080	0
13	Adjusted Auto ADT =	202,457	5,222	6,918	0
	Lookup information	202457 Ops. & 260 ft	5222 Ops. & 927.5 ft	6918 Ops. & 945 ft	#DIV/0!
14	DNL (Workchart 1) (lookup)	71	50	49	
15	Barrier Attenuation (est.)	-3	-10	-10	0
16	Partial DNL	68	40	39	0
Heavy Trucks					
17	Gradient Uphill	1.0	1.0	1.0	1.0
	-				
18	Average Speed (Table 7) Uphill	1.60	0.81	0.81	0.81
	Downhill	1.60	0.81	0.81	0.81
19	Truck ADT/2 Uphill	1,689	133	177	0
	Downhill	1,689	133	177	0
20	Up/down ADT Uphill	2,697	108	143	0
	Downhill	2,697	108	143	0
21	Combined ADT	5,394	216	286	0
22	Stop-and-Go (Table 8) x	1.0	1.0	1.0	1.8
23	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
24	Adjusted Truck ADT =	5,394	216	286	0
	Lookup information	5394 Ops. & 260 ft	216 Ops. & 927.5 ft	286 Ops. & 945 ft	#DIV/0!
25	DNL (Workchart 2) (lookup)	71	48	48	
26	Barrier Attenuation (est.)	-3	-10	-10	0
27	Partial DNL	68	38	38	0
Combined Autos and Heavy Trucks					
	Combined Autos & Heavy Trucks DNL	71	42	42	3
	Total All Roadways		71		

Worksheet C Roadway Noise Assessment - South B Elevation

Include All Roadways within 1,000 ft of the site

Roadway #1: **Interstate 70 (2 Way)**

Roadway #2: **Central Ave (SB)**

Roadway #3: **Central Ave (NB)**

Roadway #4:

		Interstate 70 (2 Way)	Central Ave (SB)	Central Ave (NB)	
1	Distance in feet from the NAL to the edge of the road				
a	Nearest Lane	323	915	940	
b	Farthest Lane	423	940	950	
c	Average (effective distance)	373	927.5	945	#DIV/0!
2	Distance to Stop Sign (do not include traffic lights)	1000	1000	1000	
3	Road gradient (in percent)	0.8	0.4	0.4	
4	Average Speed (in mph)				
a	Automobiles	70	40	40	
b	Heavy trucks - uphill	70	40	40	
c	Heavy trucks - downhill	70	40	40	
5	24 Hr average number of automobiles and medium trucks in both directions (ADT)				
	Total AADT	67,560	5,337	7,070	
a	Automobiles 85%	57,426	4,536	6,010	0
b	Medium Trucks 10%	6,756	534	707	0
c	Effective ADT	124,986	9,873	13,080	0
6	24 hour average number of heavy trucks				
a	Uphill	1,689	133	177	0
b	Downhill	1,689	133	177	0
c	Total 5%	3,378	267	354	0
7	Fraction of Nighttime Traffic (10pm to 7am)	0.15	0.15	0.15	0.15
8	Traffic projected for what year?	2010	2017	2017	
Automobiles					
9	Stop-and-Go (Table 3)	1.00	1.00	1.00	0.10
10	Average Speed (Table 4) x	1.62	0.53	0.53	0.00
11	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
12	Auto ADT x	124,986	9,873	13,080	0
13	Adjusted Auto ADT =	202,457	5,222	6,918	0
	Lookup information	202457 Ops. & 373 ft	5222 Ops. & 927.5 ft	6918 Ops. & 945 ft	#DIV/0!
14	DNL (Workchart 1) (lookup)	69	50	49	
15	Barrier Attenuation (est.)	-5	-10	-10	0
16	Partial DNL	64	40	39	0
Heavy Trucks					
17	Gradient Uphill	1.0	1.0	1.0	1.0
	-				
18	Average Speed (Table 7) Uphill	1.60	0.81	0.81	0.81
	Downhill	1.60	0.81	0.81	0.81
19	Truck ADT/2 Uphill	1,689	133	177	0
	Downhill	1,689	133	177	0
20	Up/down ADT Uphill	2,697	108	143	0
	Downhill	2,697	108	143	0
21	Combined ADT	5,394	216	286	0
22	Stop-and-Go (Table 8) x	1.0	1.0	1.0	1.8
23	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
24	Adjusted Truck ADT =	5,394	216	286	0
	Lookup information	5394 Ops. & 373 ft	216 Ops. & 927.5 ft	286 Ops. & 945 ft	#DIV/0!
25	DNL (Workchart 2) (lookup)	69	48	48	
26	Barrier Attenuation (est.)	-5	-10	-10	0
27	Partial DNL	64	38	38	0
Combined Autos and Heavy Trucks					
	Combined Autos & Heavy Trucks DNL	67	42	42	3
	Total All Roadways		67		

Worksheet C Roadway Noise Assessment - East Elevation

Include All Roadways within 1,000 ft of the site

Roadway #1: **Interstate 70 (2 Way)**

Roadway #2: **Central Ave (SB)**

Roadway #3: **Central Ave (NB)**

Roadway #4:

		Interstate 70 (2 Way)	Central Ave (SB)	Central Ave (NB)	
1	Distance in feet from the NAL to the edge of the road				
a	Nearest Lane	255	890	890	
b	Farthest Lane	355	915	915	
c	Average (effective distance)	305	902.5	902.5	#DIV/0!
2	Distance to Stop Sign (do not include traffic lights)	1000	1000	1000	
3	Road gradient (in percent)	0.8	0.4	0.4	
4	Average Speed (in mph)				
a	Automobiles	70	40	40	
b	Heavy trucks - uphill	70	40	40	
c	Heavy trucks - downhill	70	40	40	
5	24 Hr average number of automobiles and medium trucks in both directions (ADT)				
	Total AADT	67,560	5,337	7,070	
a	Automobiles 85%	57,426	4,536	6,010	0
b	Medium Trucks 10%	6,756	534	707	0
c	Effective ADT	124,986	9,873	13,080	0
6	24 hour average number of heavy trucks				
a	Uphill	1,689	133	177	0
b	Downhill	1,689	133	177	0
c	Total 5%	3,378	267	354	0
7	Fraction of Nighttime Traffic (10pm to 7am)	0.15	0.15	0.15	0.15
8	Traffic projected for what year?	2010	2017	2017	
Automobiles					
9	Stop-and-Go (Table 3)	1.00	1.00	1.00	0.10
10	Average Speed (Table 4) x	1.62	0.53	0.53	0.00
11	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
12	Auto ADT x	124,986	9,873	13,080	0
13	Adjusted Auto ADT =	202,457	5,222	6,918	0
	Lookup information	202457 Ops. & 305 ft	5222 Ops. & 902.5 ft	6918 Ops. & 902.5 ft	#DIV/0!
14	DNL (Workchart 1) (lookup)	71	50	49	
15	Barrier Attenuation (est.)	-15	0	0	0
16	Partial DNL	56	50	49	0
Heavy Trucks					
17	Gradient Uphill	1.0	1.0	1.0	1.0
	-				
18	Average Speed (Table 7) Uphill	1.60	0.81	0.81	0.81
	Downhill	1.60	0.81	0.81	0.81
19	Truck ADT/2 Uphill	1,689	133	177	0
	Downhill	1,689	133	177	0
20	Up/down ADT Uphill	2,697	108	143	0
	Downhill	2,697	108	143	0
21	Combined ADT	5,394	216	286	0
22	Stop-and-Go (Table 8) x	1.0	1.0	1.0	1.8
23	Nighttime (Table 5) x	1.00	1.00	1.00	1.00
24	Adjusted Truck ADT =	5,394	216	286	0
	Lookup information	5394 Ops. & 305 ft	216 Ops. & 902.5 ft	286 Ops. & 902.5 ft	#DIV/0!
25	DNL (Workchart 2) (lookup)	71	48	48	
26	Barrier Attenuation (est.)	-15	0	0	0
27	Partial DNL	56	48	48	0
Combined Autos and Heavy Trucks					
	Combined Autos & Heavy Trucks DNL	59	52	52	3
	Total All Roadways		60		

Worksheet D Railway Noise Assessment

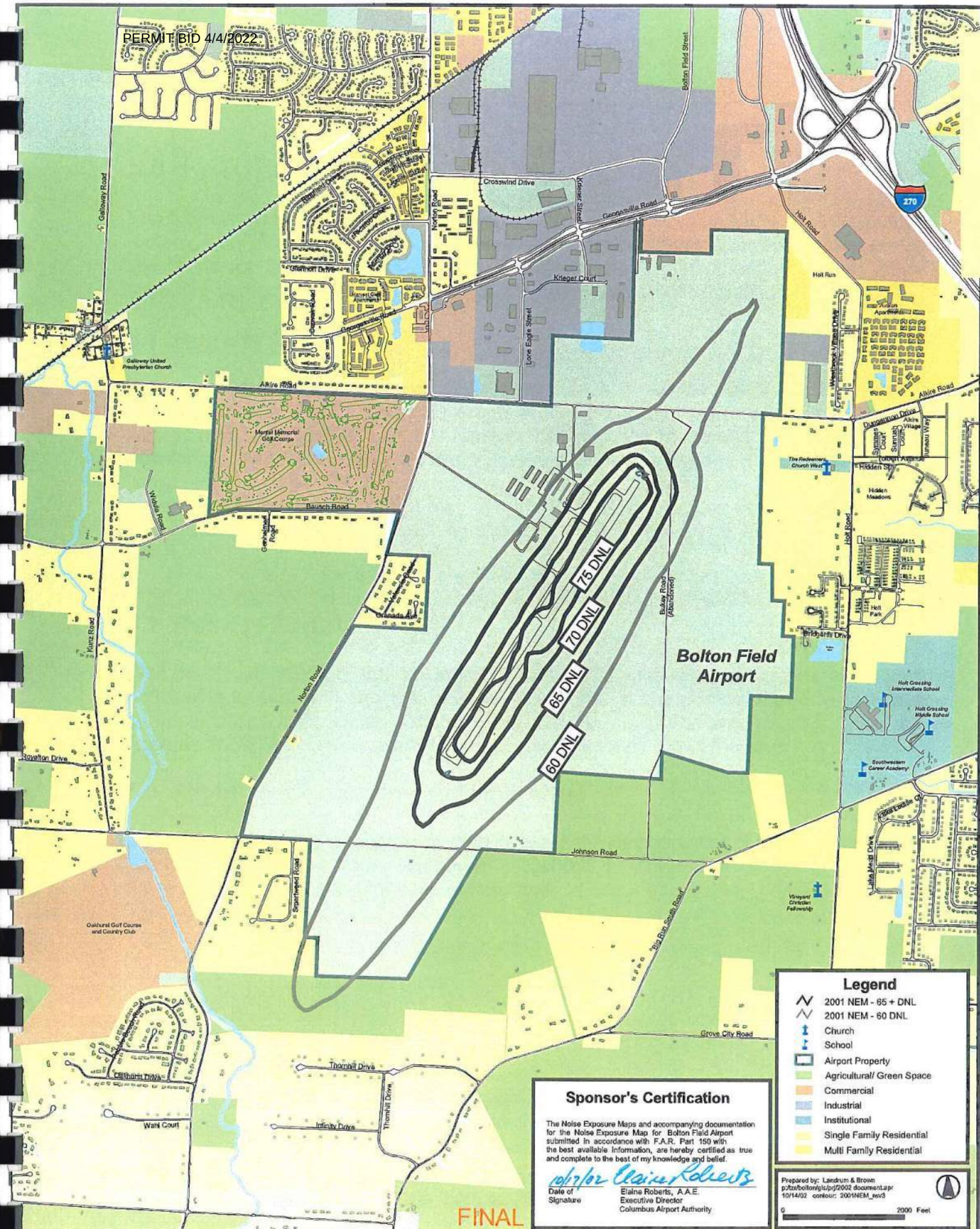
Include All Railways within 3,000 ft of the site

Railway #1: **Highland CSX**

Railway #2: **Mounds IORY**

Railway #3:

		Highland CSX	Mounds IORY	
1	Effective Distance in feet from the NAL to the center of track	2825	2875	
2	Number of trains in 24 hours			
a	Diesel	9	2	
b	Electrified	0	0	
3	Fraction of Traffic occurring at night (10pm to 7am)	0.5	0.5	0.15
4	Number of Diesel Locomotives per Train	4	4	
5	Number of railcars per train			
a	Diesel Trains	100	100	
b	Electrified Trains (include locomotive)			
6	Average Train Speed (mph)	50	25	
7	Track welded or bolted?	☐ Bolted	☐ Bolted	☐ Bolted
8	Is the site opposite a section of track where whistles or horns required for a nearby grade crossings?	☐ Horns/Whistles	☐ Horns/Whistles	☐ Horns/Whistles
Adjustments for Diesel Locomotives				
9	Number of Locomotives (divided by 2)	2	2	0
10	Average Speed (Table 9) x	0.60	1.20	#DIV/0!
11	Horns (1x or 10x) x	1	1	1
12	Nighttime (Table 5) x	2.34	2.34	1.00
13	Number of Trains x	9	2	0
14	Adjusted Number of Operations =	25	11	#DIV/0!
	Lookup information	25 Ops. & 2825 ft	11 Ops. & 2875 ft	#DIV/0!
15	DNL (Workchart 3) (lookup)	40	35	
16	Barrier Attenuation (est.)			
17	Partial DNL =	40	35	0
Adjustments for Railway Cars or Rapid Transit Trains				
18	Horns on Electric Trains (1x or 100x)	1	1	1
19	Number of cars (divided by 50) x	2	2	0
20	Average Speed (Table 10) x	2.78	0.69	0.00
21	Bolted Rails (enter 4) x	1	1	1
22	Nighttime (Table 5) x	2.34	2.34	1.00
23	Number of Trains x	9	2	0
24	Adjusted Number of Operations =	117	6	0
	Lookup information	117 Ops. & 2825 ft	6 Ops. & 2875 ft	0 Ops. & ft
25	DNL (Workchart 4) (lookup)	48	35	
26	Barrier Attenuation (est.)	0	0	0
27	Partial DNL =	48	35	0
Combined Diesel and Railway Cars				
Combined DNL for each Railway		49	38	3
Total All Railways		49		



Sponsor's Certification

The Noise Exposure Maps and accompanying documentation for the Noise Exposure Map for Bolton Field Airport submitted in accordance with F.A.R. Part 150 with the best available information, are hereby certified as true and complete to the best of my knowledge and belief.

Elaine Roberts
Date of Signature

Elaine Roberts, A.A.E.
Executive Director
Columbus Airport Authority

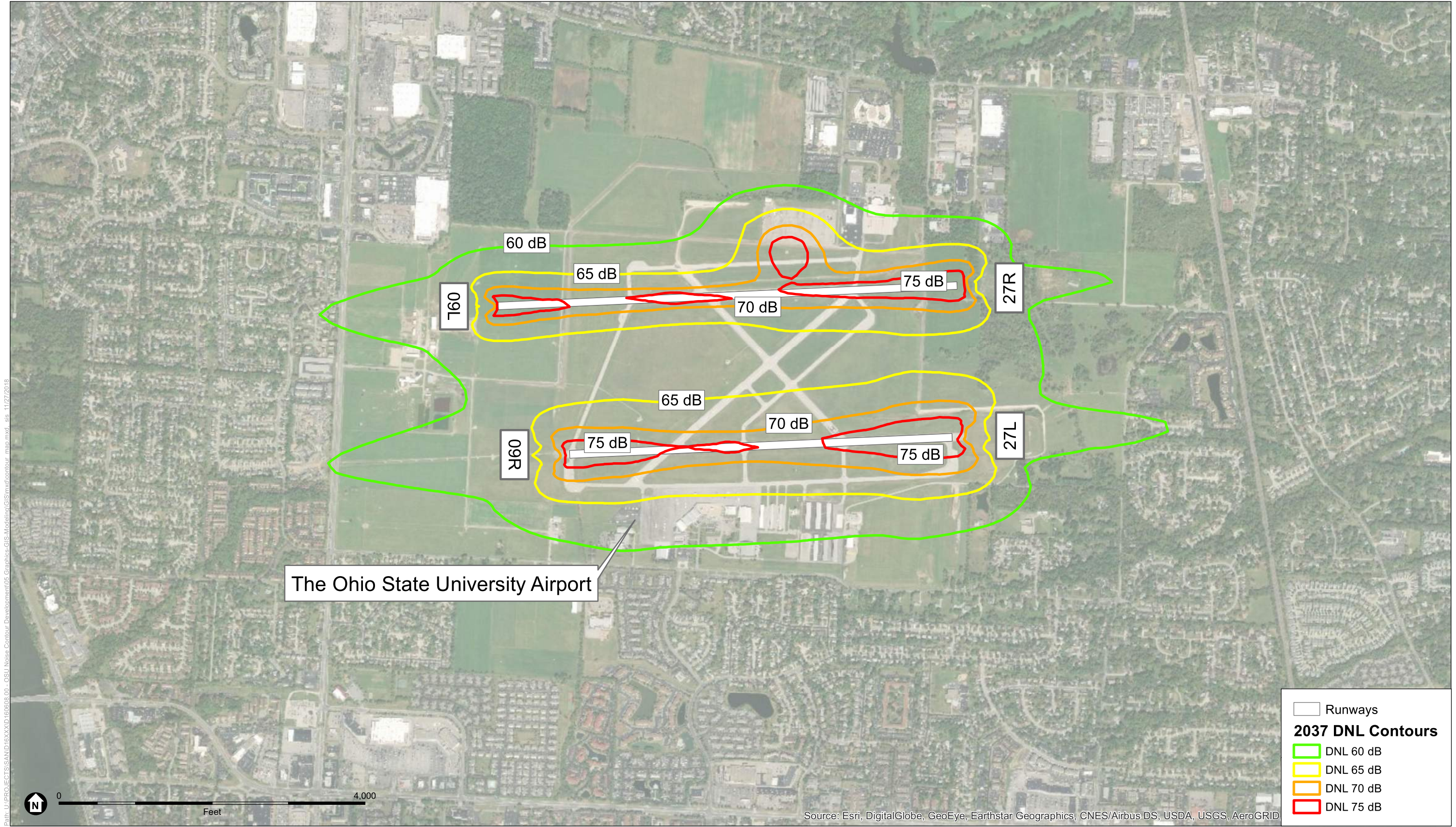
Legend

- 2001 NEM - 65 + DNL
- 2001 NEM - 60 DNL
- Church
- School
- Airport Property
- Agricultural/ Green Space
- Commercial
- Industrial
- Institutional
- Single Family Residential
- Multi Family Residential

Prepared by: Lendum & Brown
p:\bz\bolton\slcp\2002 document.apr
10/14/02 contour: 2001NEM_rev3



0 2000 Feet

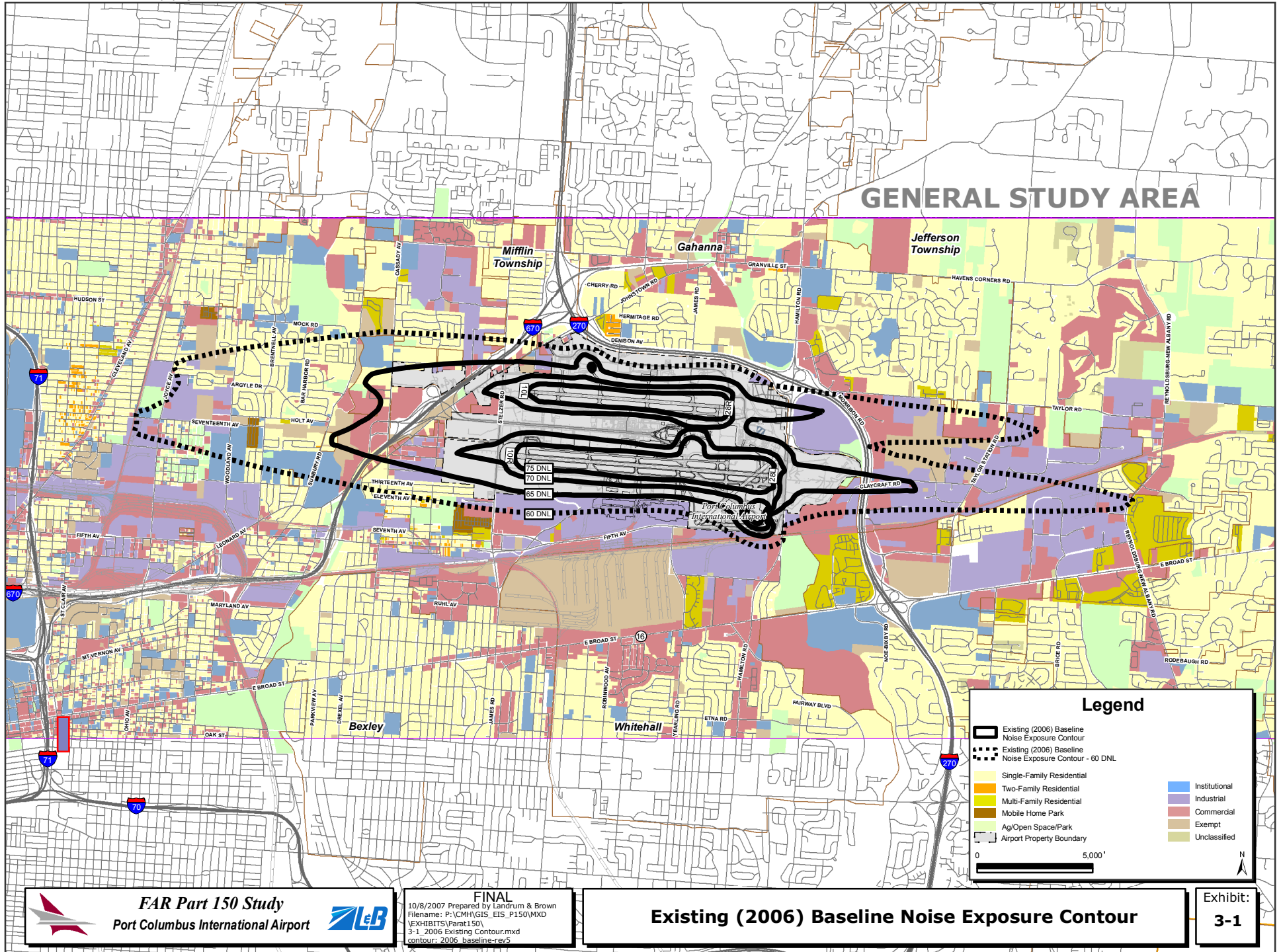


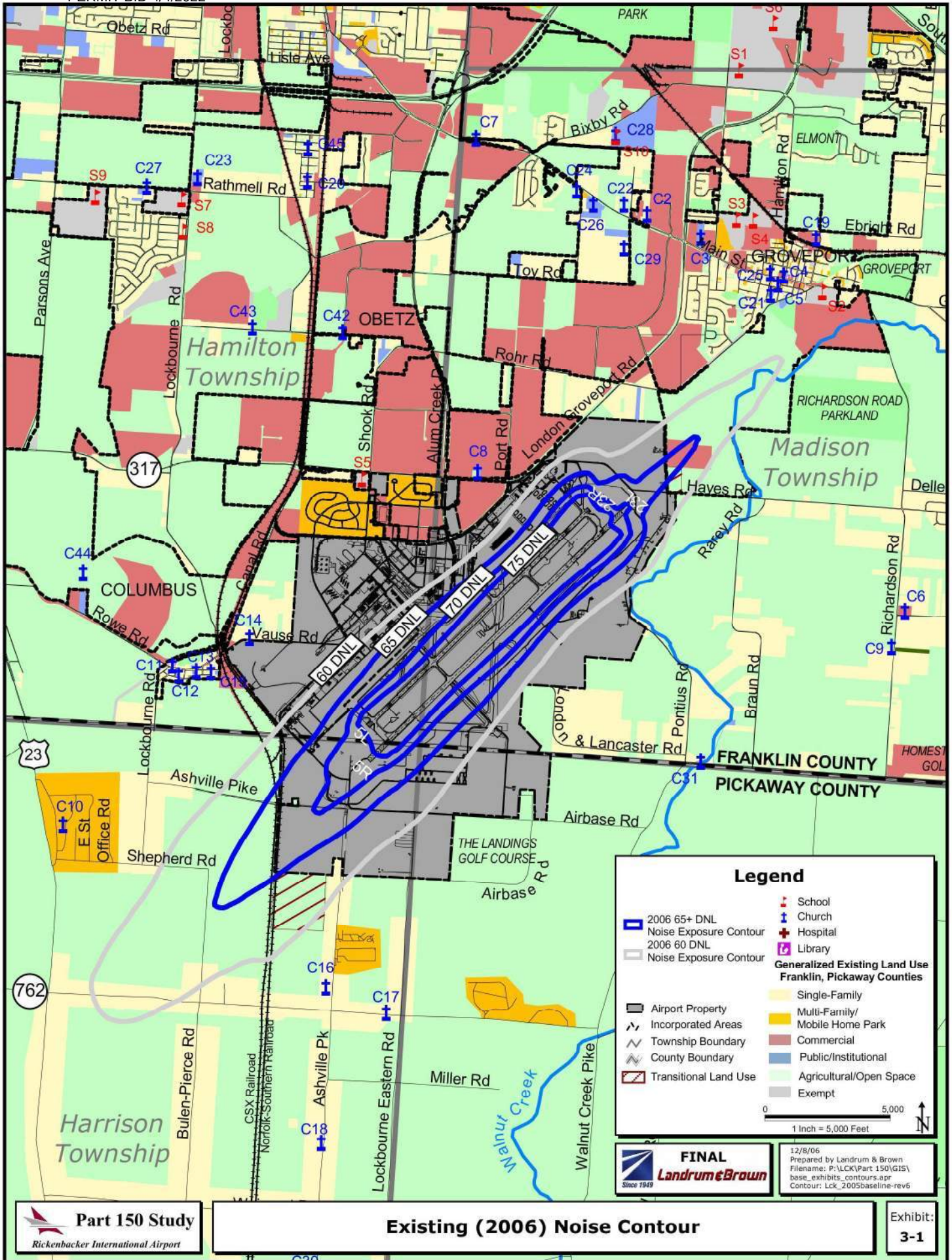
SOURCE: ESRI; ESA, 2018.

OSU Airport Master Plan Update

Figure 1
2037 DNL Contour Map







U. S. DOT CROSSING INVENTORY FORM

DEPARTMENT OF TRANSPORTATION

FEDERAL RAILROAD ADMINISTRATION

OMB No. 2130-0017

Instructions for the initial reporting of the following types of new or previously unreported crossings: For public highway-rail grade crossings, complete the entire inventory Form. For private highway-rail grade crossings, complete the Header, Parts I and II, and the Submission Information section. For public pathway grade crossings (including pedestrian station grade crossings), complete the Header, Parts I and II, and the Submission Information section. For Private pathway grade crossings, complete the Header, Parts I and II, and the Submission Information section. For grade-separated highway-rail or pathway crossings (including pedestrian station crossings), complete the Header, Part I, and the Submission Information section. For changes to existing data, complete the Header, Part I Items 1-3, and the Submission Information section, in addition to the updated data fields. Note: For private crossings only, Part I Item 20 and Part III Item 2.K. are required unless otherwise noted. An asterisk * denotes an optional field.

A. Revision Date (MM/DD/YYYY) 06 / 19 / 2020	B. Reporting Agency ☒ Railroad ☐ Transit ☐ State ☐ Other	C. Reason for Update (Select only one) ☒ Change in Data ☐ Re-Open ☐ New Crossing ☐ Date Change Only ☐ Closed ☐ Change in Primary Operating RR ☐ No Train Traffic ☐ Quiet Zone Update ☐ Admin. Correction	D. DOT Crossing Inventory Number 151841G

Part I: Location and Classification Information

1. Primary Operating Railroad Indiana & Ohio Railway [IORY]		2. State OHIO		3. County FRANKLIN	
4. City / Municipality ☒ In ☐ Near COLUMBUS		5. Street/Road Name & Block Number MOUND STREET (Street/Road Name) * (Block Number)		6. Highway Type & No. L	
7. Do Other Railroads Operate a Separate Track at Crossing? ☐ Yes ☒ No If Yes, Specify RR			8. Do Other Railroads Operate Over Your Track at Crossing? ☒ Yes ☐ No If Yes, Specify RR CSX		
9. Railroad Division or Region ☐ None NORTHERN		10. Railroad Subdivision or District ☐ None MIDLAND		11. Branch or Line Name ☒ None	
12. RR Milepost 0113.01 (prefix) (nnnn.nnn) (suffix)					
13. Line Segment *		14. Nearest RR Timetable Station RUSS		15. Parent RR (if applicable) ☒ N/A	
16. Crossing Owner (if applicable) ☒ N/A					
17. Crossing Type ☒ Public ☐ Private	18. Crossing Purpose ☒ Highway ☐ Pathway, Ped. ☐ Station, Ped.	19. Crossing Position ☒ At Grade ☐ RR Under ☐ RR Over	20. Public Access (if Private Crossing) ☐ Yes ☐ No	21. Type of Train ☒ Freight ☐ Intercity Passenger ☐ Commuter ☐ Transit ☐ Shared Use Transit ☐ Tourist/Other	22. Average Passenger Train Count Per Day ☐ Less Than One Per Day ☐ Number Per Day 0
23. Type of Land Use ☐ Open Space ☐ Farm ☐ Residential ☒ Commercial ☐ Industrial ☐ Institutional ☐ Recreational ☐ RR Yard					
24. Is there an Adjacent Crossing with a Separate Number? ☐ Yes ☒ No If Yes, Provide Crossing Number			25. Quiet Zone (FRA provided) ☒ No ☐ 24 Hr ☐ Partial ☐ Chicago Excused Date Established		
26. HSR Corridor ID ☒ N/A	27. Latitude in decimal degrees (WGS84 std: nn.nnnnnnn) 39.9449955		28. Longitude in decimal degrees (WGS84 std: -nnn.nnnnnnn) -83.0385590		29. Lat/Long Source ☒ Actual ☐ Estimated
30.A. Railroad Use *			31.A. State Use *		
30.B. Railroad Use *			31.B. State Use *		
30.C. Railroad Use *			31.C. State Use *		
30.D. Railroad Use *			31.D. State Use *		
32.A. Narrative (Railroad Use) *			32.B. Narrative (State Use) *		
33. Emergency Notification Telephone No. (posted) 800-800-3490		34. Railroad Contact (Telephone No.) 800-800-3490		35. State Contact (Telephone No.) 614-466-0407	

Part II: Railroad Information

1. Estimated Number of Daily Train Movements				
1.A. Total Day Thru Trains (6 AM to 6 PM) 1	1.B. Total Night Thru Trains (6 PM to 6 AM) 1	1.C. Total Switching Trains 0	1.D. Total Transit Trains 0	1.E. Check if Less Than One Movement Per Day ☐ How many trains per week? _____
2. Year of Train Count Data (YYYY) 2017		3. Speed of Train at Crossing 3.A. Maximum Timetable Speed (mph) 25 3.B. Typical Speed Range Over Crossing (mph) From 10 to 25		
4. Type and Count of Tracks Main 1 Siding 0 Yard 0 Transit 0 Industry 0				
5. Train Detection (Main Track only) ☐ Constant Warning Time ☒ Motion Detection ☐ AFO ☐ PTC ☐ DC ☐ Other ☐ None				
6. Is Track Signaled? ☒ Yes ☐ No		7.A. Event Recorder ☐ Yes ☒ No		7.B. Remote Health Monitoring ☐ Yes ☒ No

U. S. DOT CROSSING INVENTORY FORM

A. Revision Date (MM/DD/YYYY) 06/19/2020		PAGE 2		D. Crossing Inventory Number (7 char.) 151841G	
Part III: Highway or Pathway Traffic Control Device Information					
1. Are there Signs or Signals? ☒ Yes ☐ No		2. Types of Passive Traffic Control Devices associated with the Crossing			
2.A. Crossbuck Assemblies (count) 4		2.B. STOP Signs (R1-1) (count) 0	2.C. YIELD Signs (R1-2) (count) 0	2.D. Advance Warning Signs (Check all that apply; include count) ☒ None ☐ W10-1 ☐ W10-3 ☐ W10-11 ☐ W10-2 ☐ W10-4 ☐ W10-12	
2.E. Low Ground Clearance Sign (W10-5) ☒ Yes (count _____) ☐ No		2.F. Pavement Markings ☐ Stop Lines ☐ Dynamic Envelope ☒ RR Xing Symbols ☐ None		2.G. Channelization Devices/Medians ☐ All Approaches ☐ Median ☐ One Approach ☒ None	
				2.H. EXEMPT Sign (R15-3) ☐ Yes ☐ No	
				2.I. ENS Sign (I-13) Displayed ☒ Yes ☐ No	
2.J. Other MUTCD Signs Specify Type _____ Count _____ Specify Type _____ Count _____ Specify Type _____ Count _____		2.K. Private Crossing Signs (if private) ☐ Yes ☐ No		2.L. LED Enhanced Signs (List types)	
3. Types of Train Activated Warning Devices at the Grade Crossing (specify count of each device for all that apply)					
3.A. Gate Arms (count) Roadway 2 Pedestrian _____	3.B. Gate Configuration ☒ 2 Quad ☐ Full (Barrier) Resistance ☐ 3 Quad ☐ Median Gates	3.C. Cantilevered (or Bridged) Flashing Light Structures (count) Over Traffic Lane 2 ☐ Incandescent Not Over Traffic Lane 0 ☐ LED		3.D. Mast Mounted Flashing Lights (count of masts) 4 ☐ Incandescent ☐ LED ☒ Back Lights Included ☐ Side Lights Included	3.E. Total Count of Flashing Light Pairs 10
3.F. Installation Date of Current Active Warning Devices: (MM/YYYY) ____/____/____ ☐ Not Required		3.G. Wayside Horn ☐ Yes Installed on (MM/YYYY) ____/____/____ ☐ No		3.H. Highway Traffic Signals Controlling Crossing ☐ Yes ☒ No	3.I. Bells (count) 2
3.J. Non-Train Active Warning ☐ Flagging/Flagman ☐ Manually Operated Signals ☐ Watchman ☐ Floodlighting ☐ None				3.K. Other Flashing Lights or Warning Devices Count 0 Specify type _____	
4.A. Does nearby Hwy Intersection have Traffic Signals? ☐ Yes ☐ No	4.B. Hwy Traffic Signal Interconnection ☐ Not Interconnected ☒ For Traffic Signals ☐ For Warning Signs	4.C. Hwy Traffic Signal Preemption ☒ Simultaneous ☐ Advance	5. Highway Traffic Pre-Signals ☐ Yes ☒ No Storage Distance * _____ Stop Line Distance * _____	6. Highway Monitoring Devices (Check all that apply) ☐ Yes - Photo/Video Recording ☐ Yes - Vehicle Presence Detection ☐ None	
Part IV: Physical Characteristics					
1. Traffic Lanes Crossing Railroad Number of Lanes 4 ☐ One-way Traffic ☒ Two-way Traffic ☐ Divided Traffic		2. Is Roadway/Pathway Paved? ☒ Yes ☐ No		3. Does Track Run Down a Street? ☐ Yes ☒ No	
4. Is Crossing Illuminated? (Street lights within approx. 50 feet from nearest rail) ☒ Yes ☐ No					
5. Crossing Surface (on Main Track, multiple types allowed) Installation Date * (MM/YYYY) ____/____/____ Width * _____ Length * 147 ☒ 1 Timber ☐ 2 Asphalt ☐ 3 Asphalt and Timber ☐ 4 Concrete ☐ 5 Concrete and Rubber ☐ 6 Rubber ☐ 7 Metal ☐ 8 Unconsolidated ☐ 9 Composite ☐ 10 Other (specify) _____					
6. Intersecting Roadway within 500 feet? ☐ Yes ☒ No If Yes, Approximate Distance (feet) _____		7. Smallest Crossing Angle ☐ 0° - 29° ☐ 30° - 59° ☐ 60° - 90°		8. Is Commercial Power Available? * ☒ Yes ☐ No	
Part V: Public Highway Information					
1. Highway System ☐ (01) Interstate Highway System ☐ (02) Other Nat Hwy System (NHS) ☒ (03) Federal AID, Not NHS ☐ (08) Non-Federal AID		2. Functional Classification of Road at Crossing ☐ (0) Rural ☒ (1) Urban ☐ (1) Interstate ☐ (5) Major Collector ☐ (2) Other Freeways and Expressways ☐ (3) Other Principal Arterial ☐ (6) Minor Collector ☒ (4) Minor Arterial ☐ (7) Local		3. Is Crossing on State Highway System? ☐ Yes ☒ No	
				4. Highway Speed Limit _____ MPH ☐ Posted ☐ Statutory	
				5. Linear Referencing System (LRS Route ID) *	
				6. LRS Milepost *	
7. Annual Average Daily Traffic (AADT) Year 1987 AADT 014870		8. Estimated Percent Trucks 04 %		9. Regularly Used by School Buses? ☒ Yes ☐ No Average Number per Day 8	
				10. Emergency Services Route ☐ Yes ☐ No	
Submission Information - This information is used for administrative purposes and is not available on the public website.					
Submitted by _____ Organization _____ Phone _____ Date _____					
Public reporting burden for this information collection is estimated to average 30 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed and completing and reviewing the collection of information. According to the Paperwork Reduction Act of 1995, a federal agency may not conduct or sponsor, and a person is not required to, nor shall a person be subject to a penalty for failure to comply with, a collection of information unless it displays a currently valid OMB control number. The valid OMB control number for information collection is 2130-0017. Send comments regarding this burden estimate or any other aspect of this collection, including for reducing this burden to: Information Collection Officer, Federal Railroad Administration, 1200 New Jersey Ave. SE, MS-25 Washington, DC 20590.					

U. S. DOT CROSSING INVENTORY FORM

DEPARTMENT OF TRANSPORTATION

FEDERAL RAILROAD ADMINISTRATION

OMB No. 2130-0017

Instructions for the initial reporting of the following types of new or previously unreported crossings: For public highway-rail grade crossings, complete the entire inventory Form. For private highway-rail grade crossings, complete the Header, Parts I and II, and the Submission Information section. For public pathway grade crossings (including pedestrian station grade crossings), complete the Header, Parts I and II, and the Submission Information section. For Private pathway grade crossings, complete the Header, Parts I and II, and the Submission Information section. For grade-separated highway-rail or pathway crossings (including pedestrian station crossings), complete the Header, Part I, and the Submission Information section. For changes to existing data, complete the Header, Part I Items 1-3, and the Submission Information section, in addition to the updated data fields. Note: For private crossings only, Part I Item 20 and Part III Item 2.K. are required unless otherwise noted. An asterisk * denotes an optional field.

A. Revision Date (MM/DD/YYYY) 04 / 24 / 2020	B. Reporting Agency ☒ Railroad ☐ Transit ☐ State ☐ Other	C. Reason for Update (Select only one) ☒ Change in Data ☐ New Crossing ☐ Closed ☐ Re-Open ☐ Date Change Only ☐ No Train Traffic ☐ Quiet Zone Update ☐ Admin. Correction ☐ Change in Primary Operating RR	D. DOT Crossing Inventory Number 228636U

Part I: Location and Classification Information

1. Primary Operating Railroad CSX Transportation [CSX]		2. State OHIO		3. County FRANKLIN	
4. City / Municipality ☒ In ☐ Near COLUMBUS		5. Street/Road Name & Block Number HIGHLAND DR (Street/Road Name) * (Block Number)		6. Highway Type & No. CR176	
7. Do Other Railroads Operate a Separate Track at Crossing? ☐ Yes ☒ No If Yes, Specify RR			8. Do Other Railroads Operate Over Your Track at Crossing? ☐ Yes ☒ No If Yes, Specify RR		
9. Railroad Division or Region ☐ None GREAT LAKES		10. Railroad Subdivision or District ☐ None COLUMBUS		11. Branch or Line Name ☒ None	
12. RR Milepost CD 0005.780 (prefix) (nnnn.nnn) (suffix)					
13. Line Segment * 932990		14. Nearest RR Timetable Station * LINWORTH		15. Parent RR (if applicable) ☒ N/A	
16. Crossing Owner (if applicable) ☒ N/A					
17. Crossing Type ☒ Public ☐ Private	18. Crossing Purpose ☒ Highway ☐ Pathway, Ped. ☐ Station, Ped.	19. Crossing Position ☒ At Grade ☐ RR Under ☐ RR Over	20. Public Access (if Private Crossing) ☐ Yes ☒ No	21. Type of Train ☒ Freight ☐ Intercity Passenger ☐ Commuter ☐ Transit ☐ Shared Use Transit ☐ Tourist/Other	22. Average Passenger Train Count Per Day ☐ Less Than One Per Day ☐ Number Per Day 0
23. Type of Land Use ☐ Open Space ☐ Farm ☒ Residential ☐ Commercial ☐ Industrial ☐ Institutional ☐ Recreational ☐ RR Yard					
24. Is there an Adjacent Crossing with a Separate Number? ☐ Yes ☒ No If Yes, Provide Crossing Number			25. Quiet Zone (FRA provided) ☒ No ☐ 24 Hr ☐ Partial ☐ Chicago Excused Date Established		
26. HSR Corridor ID ☒ N/A	27. Latitude in decimal degrees (WGS84 std: nn.nnnnnnn) 40.0397154		28. Longitude in decimal degrees (WGS84 std: -nnn.nnnnnnn) -83.0409840		29. Lat/Long Source ☒ Actual ☐ Estimated
30.A. Railroad Use *			31.A. State Use *		
30.B. Railroad Use *			31.B. State Use *		
30.C. Railroad Use *			31.C. State Use *		
30.D. Railroad Use *			31.D. State Use *		
32.A. Narrative (Railroad Use) *			32.B. Narrative (State Use) *		
33. Emergency Notification Telephone No. (posted) 800-232-0144		34. Railroad Contact (Telephone No.) 904-366-3051		35. State Contact (Telephone No.) 614-466-0407	

Part II: Railroad Information

1. Estimated Number of Daily Train Movements				
1.A. Total Day Thru Trains (6 AM to 6 PM) 2	1.B. Total Night Thru Trains (6 PM to 6 AM) 4	1.C. Total Switching Trains 3	1.D. Total Transit Trains 0	1.E. Check if Less Than One Movement Per Day ☐ How many trains per week? _____
2. Year of Train Count Data (YYYY) 2020		3. Speed of Train at Crossing 3.A. Maximum Timetable Speed (mph) 50 3.B. Typical Speed Range Over Crossing (mph) From 50 to 50		
4. Type and Count of Tracks Main 2 Siding 0 Yard 0 Transit 0 Industry 0				
5. Train Detection (Main Track only) ☒ Constant Warning Time ☐ Motion Detection ☐ AFO ☐ PTC ☐ DC ☐ Other ☐ None				
6. Is Track Signaled? ☒ Yes ☐ No		7.A. Event Recorder ☐ Yes ☒ No		7.B. Remote Health Monitoring ☐ Yes ☒ No

U. S. DOT CROSSING INVENTORY FORM

A. Revision Date (MM/DD/YYYY) 04/24/2020		PAGE 2		D. Crossing Inventory Number (7 char.) 228636U	
Part III: Highway or Pathway Traffic Control Device Information					
1. Are there Signs or Signals? ☒ Yes ☐ No		2. Types of Passive Traffic Control Devices associated with the Crossing			
2.A. Crossbuck Assemblies (count) 0		2.B. STOP Signs (R1-1) (count) 0	2.C. YIELD Signs (R1-2) (count) 0	2.D. Advance Warning Signs (Check all that apply; include count) ☒ None ☐ W10-1 ☐ W10-3 ☐ W10-11 ☐ W10-2 ☐ W10-4 ☐ W10-12	
2.E. Low Ground Clearance Sign (W10-5) ☐ Yes (count _____) ☐ No		2.F. Pavement Markings ☒ Stop Lines ☐ Dynamic Envelope ☒ RR Xing Symbols ☐ None		2.G. Channelization Devices/Medians ☐ All Approaches ☐ Median ☐ One Approach ☐ None	
				2.H. EXEMPT Sign (R15-3) ☐ Yes ☐ No	
				2.I. ENS Sign (I-13) Displayed ☒ Yes ☐ No	
2.J. Other MUTCD Signs Specify Type _____ Count _____ Specify Type _____ Count _____ Specify Type _____ Count _____		2.K. Private Crossing Signs (if private) ☐ Yes ☐ No		2.L. LED Enhanced Signs (List types)	
3. Types of Train Activated Warning Devices at the Grade Crossing (specify count of each device for all that apply)					
3.A. Gate Arms (count) Roadway <u>2</u> Pedestrian <u>0</u>	3.B. Gate Configuration ☒ 2 Quad ☐ Full (Barrier) Resistance ☐ 3 Quad ☐ Median Gates ☐ 4 Quad	3.C. Cantilevered (or Bridged) Flashing Light Structures (count) Over Traffic Lane <u>0</u> ☐ Incandescent Not Over Traffic Lane <u>0</u> ☐ LED		3.D. Mast Mounted Flashing Lights (count of masts) <u>2</u> ☒ Incandescent ☐ LED ☒ Back Lights Included ☐ Side Lights Included	3.E. Total Count of Flashing Light Pairs 4
3.F. Installation Date of Current Active Warning Devices: (MM/YYYY) _____/_____/_____ ☒ Not Required		3.G. Wayside Horn ☐ Yes Installed on (MM/YYYY) ____/____/_____ ☒ No		3.H. Highway Traffic Signals Controlling Crossing ☐ Yes ☒ No	3.I. Bells (count) 1
3.J. Non-Train Active Warning ☐ Flagging/Flagman ☐ Manually Operated Signals ☐ Watchman ☐ Floodlighting ☐ None				3.K. Other Flashing Lights or Warning Devices Count <u>0</u> Specify type _____	
4.A. Does nearby Hwy Intersection have Traffic Signals? ☐ Yes ☐ No	4.B. Hwy Traffic Signal Interconnection ☒ Not Interconnected ☐ For Traffic Signals ☐ For Warning Signs	4.C. Hwy Traffic Signal Preemption ☐ Simultaneous ☐ Advance	5. Highway Traffic Pre-Signals ☐ Yes ☐ No Storage Distance * _____ Stop Line Distance * _____	6. Highway Monitoring Devices (Check all that apply) ☐ Yes - Photo/Video Recording ☐ Yes - Vehicle Presence Detection ☐ None	
Part IV: Physical Characteristics					
1. Traffic Lanes Crossing Railroad Number of Lanes <u>2</u> ☐ One-way Traffic ☐ Two-way Traffic ☐ Divided Traffic		2. Is Roadway/Pathway Paved? ☒ Yes ☐ No		3. Does Track Run Down a Street? ☐ Yes ☒ No	
4. Is Crossing Illuminated? (Street lights within approx. 50 feet from nearest rail) ☐ Yes ☐ No					
5. Crossing Surface (on Main Track, multiple types allowed) Installation Date * (MM/YYYY) ____/____/_____ ☐ 1 Timber ☐ 2 Asphalt ☒ 3 Asphalt and Timber ☐ 4 Concrete ☐ 5 Concrete and Rubber ☐ 6 Rubber ☐ 7 Metal ☐ 8 Unconsolidated ☐ 9 Composite ☐ 10 Other (specify) _____					
6. Intersecting Roadway within 500 feet? ☐ Yes ☒ No If Yes, Approximate Distance (feet) _____		7. Smallest Crossing Angle ☐ 0° - 29° ☐ 30° - 59° ☒ 60° - 90°		8. Is Commercial Power Available? * ☒ Yes ☐ No	
Part V: Public Highway Information					
1. Highway System ☐ (01) Interstate Highway System ☐ (02) Other Nat Hwy System (NHS) ☒ (03) Federal AID, Not NHS ☐ (08) Non-Federal AID		2. Functional Classification of Road at Crossing ☐ (0) Rural ☒ (1) Urban ☐ (1) Interstate ☒ (5) Major Collector ☐ (2) Other Freeways and Expressways ☐ (3) Other Principal Arterial ☐ (6) Minor Collector ☐ (4) Minor Arterial ☐ (7) Local		3. Is Crossing on State Highway System? ☐ Yes ☒ No	
				4. Highway Speed Limit _____ MPH ☐ Posted ☐ Statutory	
				5. Linear Referencing System (LRS Route ID) *	
				6. LRS Milepost *	
7. Annual Average Daily Traffic (AADT) Year <u>2004</u> AADT <u>004315</u>		8. Estimated Percent Trucks <u>04</u> %		9. Regularly Used by School Buses? ☐ Yes ☒ No Average Number per Day _____	
				10. Emergency Services Route ☐ Yes ☐ No	
Submission Information - This information is used for administrative purposes and is not available on the public website.					
Submitted by _____ Organization _____ Phone _____ Date _____					
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Record

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of 1

Goto Record

go

Location ID	ODOT_538	MPO ID	
Type	LINK	HPMS ID	
On NHS	No	On HPMS	No
LRS ID		LRS Loc Pt.	
SF Group		Route Type	IR
AF Group		Route	70
GF Group		Active	Yes
Class Dist Grp		Category	ODOT
Seas Class Grp			
WIM Group			
Funct'l Class		Milepost	
Located On	IR 70		
Loc On Alias			
From Road	11.21		
To Road	11.64		
More Detail ▶			

STATION DATA

The counts on this segment were extracted from the Ohio DOT's Traffic Survey Reports. For more detail, please check their [website](#).

Directions: 2-WAY ?

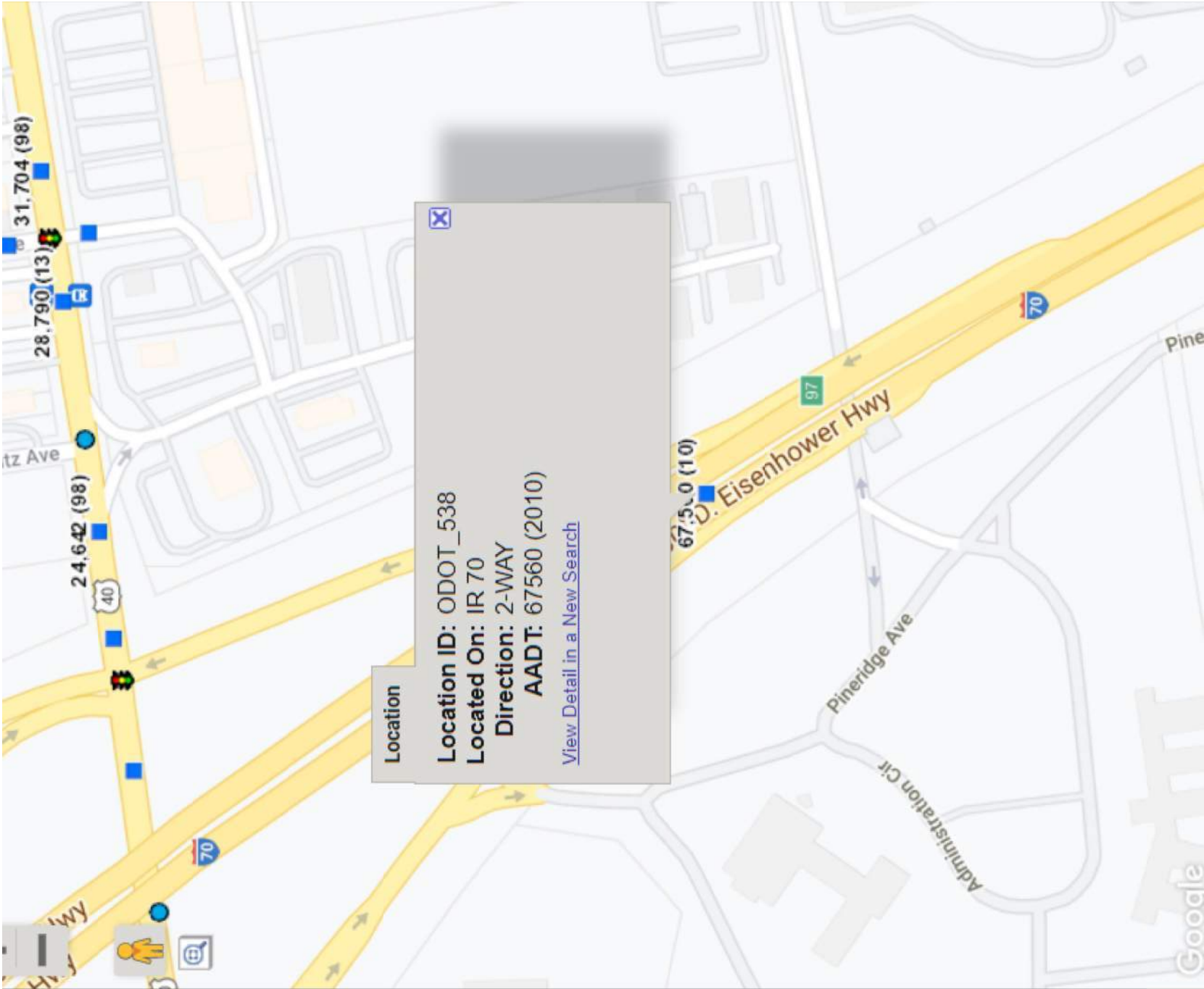
AADT ?									
Year	AADT	DHV-30	K %	D %	PA	BC	Src		
2010	67,560				57,360 (85%)	10,200 (15%)			
2006	77,510				66,250 (85%)	11,260 (15%)			
2003	98,660				83,560 (85%)	15,100 (15%)			
2001	93,490				79,180 (85%)	14,310 (15%)			
1994	85,420				70,550 (83%)	14,870 (17%)			
								1-5 of 6	
<<		<	>	>>					

Travel Demand Model

Model Year	Model AADT	AM PHV	AM PPV	MD PHV	MD PPV	PM PHV	PM PPV	NT PHV	NT PPV

VOLUME COUNT

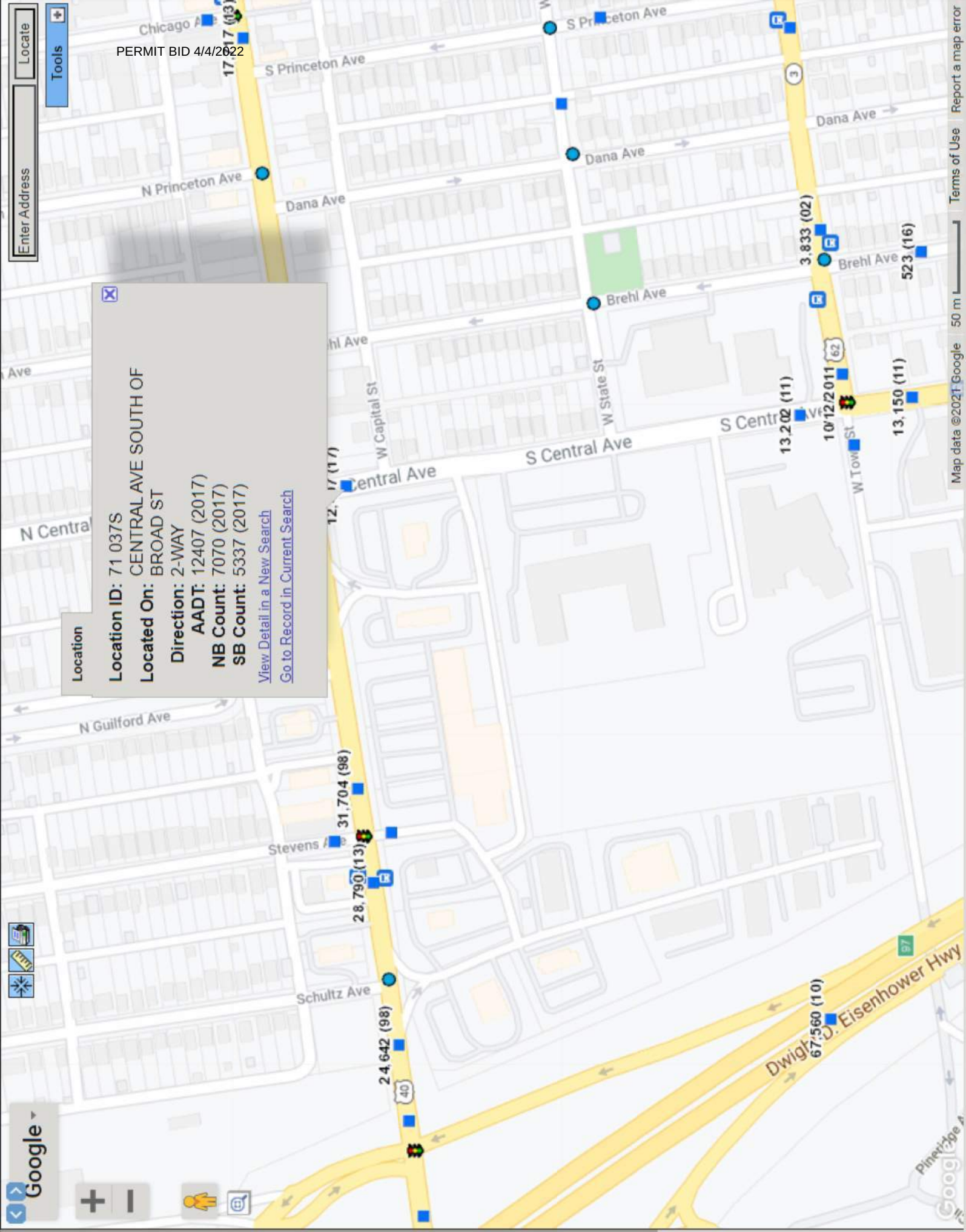
VOLUME TREND ?		
Year	Annual Growth	
2010	-3%	

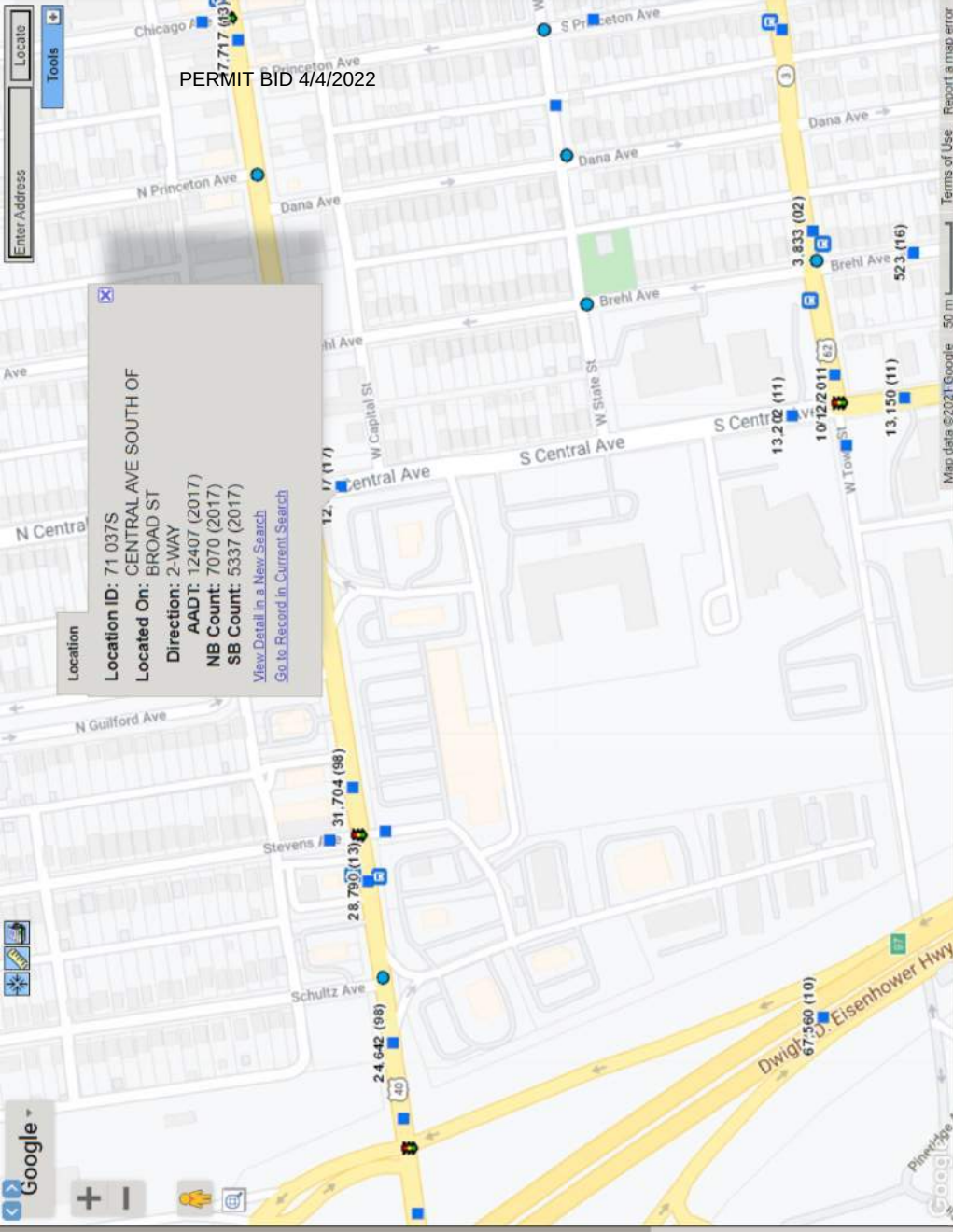


Disclaimer: The information shown in this database is compiled from various sources available to the Mid-Ohio Regional Planning Commission which we believe to be reliable.

List View	All DIRs	TMC	All Approaches

Record	◀◀	1	▶▶	of 1	Goto Record	go
Location ID	71 037S					
Type	SPOT					
On NHS						
LRS ID						
SF Group						
AF Group						
GF Group						
Class Dist Grp						
Seas Class Grp						
WIM Group						
Fnc'tl Class	URBAN MINOR ART					
Located On	CENTRAL AVE					
Loc On Alias						
SOUTH OF	BROAD ST					
More Detail ▶						
STATION DATA						





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List View	All Dirs	TMC	All Approaches
Record	1 of 1	Goto Record	GO
Location ID	71 037S	MPO ID	
Type	SPOT	HPMS ID	
On NHS		On HPMS	
LRS ID		LRS Loc Pt.	
SF Group		Route Type	
AF Group		Route	
GF Group		Active	Yes
Class Dist Grp		Category	CNT
Seas Class Grp			
WIM Group			
Frict1 Class	URBAN MINOR ART	Milepost	
Located On	CENTRAL AVE		
Loc On Alias			
	SOUTH OF BROAD ST		
More Detail			

STATION DATA

Directions: 2-WAY NB SB

Year	AADT	DHV-30	K %	D %	PA	BC	Src
2017	5,337						
2011	5,235 ⁴						

Model	Model AADT	AM PHV	AM PPV	MD PHV	MD PPV	PM PHV	PM PPV	NT PHV	NT PPV

VOLUME COUNT