SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Work of this Section includes:

1. Sleeves without waterstop.
2. Sleeves with waterstop.
3. Stack-sleeve fittings.
4. Sleeve-seal systems.
5. Grout.
6. Silicone sealants.
7. Escutcheons.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the fire-suppression equipment Sections.

    a. Include construction details, material descriptions, and dimensions of components.
    b. Include operating characteristics and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 COORDINATION

PART 2 - PRODUCTS

2.1 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Description: Manufactured PVC/HDPE steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Description: Manufactured, Dura-coated or Duco-coated galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

    a. Hydrostatic Seal: 20 psig minimum.
    b. Sealing Elements: EPDM-rubber, High-temperature-silicone, Nitrile (Buna-N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
    c. Pressure Plates: Carbon steel Composite plastic Stainless steel Stainless steel, Type 316.
    d. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating Stainless steel Stainless steel, Type 316, of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi , 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

a. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, 100/50, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

a. Standard: ASTM C920, Type S, Grade P, Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.2 ESCUTCHEONS

A. Escutcheon Types:

1. One-Piece, Steel Type: With **p**olished, chrome-plated finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

B. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

A. Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.2 INSTALLATION OF SLEEVES, GENERAL

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 2-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire-resistance of floor/slab/wall.

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 that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width centered in concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves.

3.4 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.5 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. 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.

3.6 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.7 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

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

3.8 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. Sleeves with waterstops or stack-sleeve fittings.

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.9 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, steel, cast brass or split plate steel with polished, chrome-plated finish.
3. Insulated Piping:

Retain one of first four subparagraphs below.

a. One piece, steel with polished, chrome-plated finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with polished, chrome-plated ,polished brass finish.
d. One piece, stamped steel or split plate, stamped steel with concealed hinge or split plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One piece, steel with polished, chrome-plated, polished brass finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with polished, chrome-plated ,polished brass finish.
    d. One piece, stamped steel or split plate, stamped steel with concealed hinge or split plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One piece, steel with polished, chrome-plated, polished brass finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with polished, chrome-plated polished brass finish.
    d. One piece, stamped steel or split plate, stamped steel with concealed hinge or split plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated, rough-brass finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge or split plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated rough-brass finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge or split plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

END OF SECTION

SECTION 21 05 17

SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves without waterstop.
2. Sleeves with waterstop.
3. Stack-sleeve fittings.
4. Sleeve-seal systems.
5. Grout.
6. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 SLEEVES WITHOUT WATERSTOP

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

C. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch (0.6-mm) minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

1.5 SLEEVES WITH WATERSTOP

A. Description: Manufactured PVC/HDPE steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

1.6 STACK-SLEEVE FITTINGS

A. Description: Manufactured, Dura-coated or Duco-coated galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

1.7 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Designed to form a hydrostatic seal of 20 psig minimum.
2. Sealing Elements: EPDM-rubber High-temperature-silicone Nitrile Buna N interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
3. Pressure Plates: Carbon steel Composite plastic Stainless steel Stainless steel, Type 316.
4. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

1.8 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000 psi 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

1.9 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

1. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

B. Silicone, S, P, T, NT: Single-component, 100/50, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

1. Standard: ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 2 - EXECUTION

2.1 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

2.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves.

2.3 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inchannular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

2.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

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.

2.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

2. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

2.6 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for1-inch (25-mmannular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. Sleeves with waterstops or stack-sleeve fittings.

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

END OF SECTION

SECTION 21 05 18

ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Steel Type: With chrome-plated finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and 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 ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor plate.
2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 21 05 23

GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Two-piece ball valves with indicators.
2. Iron butterfly valves with indicators.
3. Check valves.
4. Iron OS&Y gate valves.
5. Trim and drain valves.

1.3 DEFINITIONS

A. OS&Y: Outside screw and yoke.

B. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

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, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

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 operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Fire Main Equipment: HAMV - Main Level.

a. Ball Valves, System Control: HLUG - Level 3.
b. Butterfly Valves: HLXS - Level 3.
c. Check Valves: HMER - Level 3.
d. Gate Valves: HMRZ - Level 3.

2. Sprinkler System and Water Spray System Devices: VDGT - Main Level.

a. Valves, Trim and Drain: VQGU - Level 1.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves.
3) Miscellaneous valves.

C. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B31.9 for building services piping valves.

D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

E. NFPA Compliance for Valves:

1. Comply with NFPA 13, and NFPA 24.

F. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Hand lever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.3 TWO-PIECE BALL VALVES WITH INDICATORS

A. Description:

1. UL 1091, except with ball instead of disc and FM Global approved for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear.

.

8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer Grooved-end connections.

2.5 CHECK VALVES

A. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.6 IRON OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged or Grooved.

2.7 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Description:

a. Pressure Rating: 250 psig
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: hand lever.

i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Globe Valves:

1. Description:

a. Pressure Rating: 250 psig
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION, GENERAL

A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:

1. Section 21 10 00 "Water-Based Fire-Suppression Systems" for application of valves in fire-suppression standpipes; wet-pipe, fire-suppression sprinkler systems; and dry-pipe, fire-suppression sprinkler systems.
2. Section 21 13 39 "Foam-Water Systems" for application of valves in AFFF piping.
3. Section 33 14 15 "Site Water Distribution Piping" for application of valves in fire-suppression water-service piping.

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 double-check valve assembly in each fire-protection water-supply connection.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 21 05 53 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION

SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 21 05 16 "Expansion Fittings and Loops for Fire-Suppression Piping" for pipe guides and anchors.
3. Section 21 05 48 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" Section 21 05 48.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for vibration isolation devices and seismic restraints

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

C. NFPA Compliance: Comply with NFPA 13 "UL Compliance" Paragraph below covers design variations of hangers, as defined in NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel

B. Copper Pipe and Tube Hangers:

1. Description: Copper-coated-steel, factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Selected for applicable load criteria.
5. Channel Nuts: Formed or stamped 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

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped 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

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved 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: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Indoor Applications: Zinc-coated or Stainless steel.

2.6 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.7 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, 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 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

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.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. 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 A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.

D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

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.

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. MSS SP-58, Type 39 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. MSS SP-58, Type 40 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 of same thickness as piping insulation.

3.3 INSTALLATION OF 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.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/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.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches

3.6 PAINTING

A. Touchup:

1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 23 "Interior Painting”.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

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

B. Comply with NFPA requirements 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 finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and, metal framing systems, and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel 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 thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30
2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
7. 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.
8. 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.
9. 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.

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: Comply with NFPA requirements.

L. Building Attachments: Comply with NFPA requirements. 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. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

M. Saddles and Shields: Comply with NFPA requirements. 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. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 21 05 53

IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

D. Valve-numbering scheme.

E. Valve Schedules: Provide for fire-suppression piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032 inch aluminum, 0.032 inch anodized aluminum, 0.032 inch thick, with predrilled or stamped holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless steel rivets or self-tapping screws.
6. 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, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. 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 and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch 1/8 inch thick, with predrilled holes for attachment hardware.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 WARNING TAPE

A. Material: Vinyl.

B. Minimum Thickness: 0.005 inch

C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

E. Maximum Temperature: 160 deg F

F. Minimum Width: 4 inches

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping

2.5 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters in accordance with ASME A13.1 for piping
2. Stencil Material: Aluminum, brass, or fiberboard.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.
5. Letter and Background Color: As indicated for specific application under Part 3.

2.6 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.04 inch stainless steel, 0.024 inch aluminum, 0.031 inch or anodized aluminum, 0.031 inch thick, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire link chain beaded chain or S-hook.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. 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. Include valve-tag schedule in operation and maintenance data.

2.7 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 Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of fire-suppression equipment.

B. Sign and Label Colors:

1. White letters on an ANSI Z535.1 safety-red background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Stenciled Pipe-Label Option: Stenciled labels showing service and flow direction 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.

D. Pipe-Label Locations: 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. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit a view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. > in areas of congested piping and equipment.

E. Flow- Direction Arrows: Provide arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Fire-Suppression Pipe Label Color Schedule:

1. Fire-Suppression Pipe Labels: White letters on an ANSI Z535.1 safety-red background

3.6 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule in the operating and maintenance manual. Include the identification "FSV" on all fire-suppression system valve tags.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

a. Wet-Pipe Sprinkler System: 1-1/2 inches 2 inches

2. Valve-Tag Color: White letters on an ANSI Z535.1 safety-red background

3.7 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background

B. Attach warning tags, with proper message, to equipment and other items where scheduled.

END OF SECTION

SECTION 21 10 00

WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-suppression piping, fittings, and appurtenances.
2. Fire department connections.
3. Hose connections and hose stations.
4. System control valves.
5. Fire-suppression piping specialties.
6. Cover systems for sprinkler piping.
7. Sprinklers.
8. Alarm devices.
9. Manual control stations.
10. Control panels.
11. Pressure gauges.

B. Related Requirements:

1. Section 33 14 15 "Site Water Distribution Piping" for site fire-suppression water-service and backflow prevention devices.

1.3 DEFINITIONS

A. Standard-Pressure Fire-Suppression System Piping: Piping designed to operate at working pressure of 175 psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles.
b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Prepare in accordance with NFPA 13 section "Working Plans."

a. Include plans, elevations, and sections of the system piping and details.
b. Include detailed riser diagram and schematic diagram showing system supply, supply connection, devices, valves, pipe and fittings, as well as the delineation of the standard-pressure and high-pressure portions of the fire-suppression system.
c. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Prepare computer-generated hydraulic calculations in accordance with the following:

a. Name of hydraulic program used.
b. Water supply information, including fire hydrant flow test data report.

3. Submit documents and calculations prepared by NICET Level III-certified technician, "Water-Based Systems Layout." NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.
4. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For fire-suppression systems indicated to comply with performance requirements and design criteria, including analysis data, prepared by NICET Level III-certified technician, "Water-Based Systems Layout." NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-suppression systems and specialties to include in emergencies, operation, and maintenance manuals.

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. 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.

2. System control valves.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by NICET Level III-certified technician, "Water-Based Systems Layout."

B. Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Automatic wet-pipe sprinkler system.

B. Seismic Performance: Fire-suppression system piping to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7. See Section 21 05 48 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

C. Fire-Suppression System Components, Devices, and Accessories: Listed in UL's "Fire Protection Equipment Directory" and FM Approvals' "Approval Guide."

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. Fire-suppression system equipment, specialties, accessories, installation, and testing to comply with NFPA 13

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

G. Delegated Design: Engage a NICET Level III-certified technician, "Water-Based Systems Layout" to design fire-suppression systems.

1. Fire-Hydrant Flow Test:

a. Available fire-hydrant flow test records indicate the following conditions:

1) Date: 05/29/2025
2) Time: 8:32 a.m.
3) Static Pressure at Residual Fire Hydrant R: 72 psig
4) Measured Flow at Flow Fire Hydrant F: 1021 gpm
5) Residual Pressure at Residual Fire Hydrant R: 62psig

b. Fire-hydrant flow test must be performed within previous 12months prior to completion of design documents and hydraulic calculations.

2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications:

a. Electrical Equipment Rooms: Ordinary Hazard, Group 1
b. Processing, Equalization Tanks, Lab and Interior Loading Docks Light Hazard
c. General Storage Areas: Ordinary Hazard, Group 1
d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1
e. Offices, including Data Processing: Light Hazard

4. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500 sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq. ft. over 1500 sq. ft. area.

5. Maximum protection area per sprinkler in accordance with UL listing.
6. 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: In accordance with NFPA 13 recommendations unless otherwise indicated.

7. Total Combined Hose-Stream Demand Requirement: In accordance with NFPA 13 unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm for 30 minutes
b. Ordinary-Hazard Occupancies: 250 gpm for 60 minutes

H. Obtain documented approval of fire-suppression system design from AHJs.

2.2 FIRE-SUPPRESSION PIPING, FITTINGS, AND APPURTENANCES

A. Steel Pipe, Fittings, and Appurtenances:

1. Schedule 40 Steel Pipe: black-steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.

    a. Standards:

        1) UL 852.
        2) FM 1630.

    b. Factory-applied exterior coating.
    c. Factory-applied bacterial-resistant internal coating to reduce microbiologically influenced corrosion.
    d. Pipe ends may be factory or field formed to match joining method.

2. Schedule 10 Steel Pipe: black-steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.

    a. Standards:

        1) UL 852.
        2) FM 1630.

    b. Factory-applied exterior coating.
    c. Factory-applied bacterial resistant internal coating to reduce microbiologically influenced corrosion.
    d. Pipe ends may be factory or field formed to match joining method.

3. Steel Pipe Nipples: and black steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
4. Steel Couplings: uncoated steel, ASTM A865/A865M, threaded.
5. Gray-Iron Threaded Fittings: Galvanized and uncoated gray-iron threaded fittings, ASME B16.4, Class 125, standard pattern.
6. Malleable- or Ductile-Iron Unions: ASME B16.3.
7. Cast-Iron Flanges: ASME B16.1, Class 125.
8. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

    a. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick and ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.

        1) Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
        2) Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

    b. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.

9. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

a. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

10. Plain-End-Pipe Fittings:

a. Pressure Rating: 175 psig minimum.
b. Plain-End Fittings for Steel Piping: Uncoated plain-end fittings, ASTM A53/A53M, carbon steel or ASTM A106/A106M, forged steel with dimensions matching steel pipe.
c. Plain-End-Pipe Couplings for Steel Piping: Rigid pattern for steel-pipe dimensions, ductile-iron or malleable-iron housing. Include EPDM-rubber gasket, and bolts and nuts.

11. Grooved-Joint, Steel-Pipe Appurtenances:

a. Pressure Rating: 175 psig minimum.
b. Grooved-End Fittings for Steel Piping: Uncoated grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
c. 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 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connection, Exposed Type:

1. Standard: UL 405.
2. Description: Exposed, projecting, for wall mounting.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Round, brass, wall type.
8. Outlet: Back, with pipe threads.
9. Number of Inlets: Two
10. Escutcheon Plate Marking: "AUTO SPKR"
11. Finish: Rough brass or bronze
12. Outlet Size: NPS 4

B. Fire Department Connection, Auxiliary Type:

1. Standard: UL 405.
2. Type: Exposed
3. Pressure Rating: 175 psig minimum.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Universal, threadless (Storz) connector in accordance with NFPA 1963.

6. Caps: Corrosion-resistant metal, with gasket and chain.
7. Escutcheon Plate: Round, brass.
8. Outlet: Back, with pipe threads.
9. Number of Inlets: One.
10. Escutcheon Plate Marking: "AUTO SPKR".
11. Finish: Polished brass
12. Outlet Size: NPS 4 (DN 100)

2.4 SYSTEM CONTROL VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Valves: 175 psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. System Control Valve, Alarm Valve:

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

2.5 FIRE-SUPPRESSION PIPING SPECIALTIES

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-tee 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 and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
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 or grooved.

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" or FM Approvals' "Approval Guide."
2. Pressure Rating: 175 psig
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. Standards:

   a. UL 2443.
   b. FM 1637.

2. Description: 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.

G. Automatic (Ball-Drip) Drain Valves:

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

H. Automatic Air Vent Assembly:

1. Description: Automatic air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly. Approved for use in wet-pipe fire-suppression system.
2. Vents oxygen continuously from system.
3. Float valve to prevent water discharge.
4. Minimum Water Working Pressure Rating: 175 psig

2.6 SPRINKLERS

A. Standards:

1. UL 199.
2. UL 1767.
3. UL 1626.
4. FM 2000.
5. FM 2008.
6. FM 2030.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."

C. Pressure Rating for Sprinklers:

1. Standard Automatic Sprinklers: 175 psig minimum.

D. Sprinklers, Automatic Wet with Heat-Responsive Element:

1. 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.
2. Standard Spray, Standard Response:

a. Upright.
b. Pendent.
c. Recessed pendent.
d. Flat, concealed pendent.
e. Vertical sidewall.
f. Horizontal sidewall.

3. Standard Spray, Quick Response:

a. Upright.
b. Pendent.
c. Recessed pendent.
d. Flat, concealed pendent.
e. Vertical sidewall.
f. Horizontal sidewall.
g. Flat, concealed horizontal sidewall.

E. Sprinkler Finishes: Chrome plated and bronze

F. Special Coatings: corrosion-resistant paint.

G. 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

H. Sprinkler Guards and Water Shields:

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

2.7 ALARM DEVICES

A. Match alarm-device material and connection types to piping and equipment materials and connection types.

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:8-1/2-inch diameter.
5. Components: Shaft length, bearings, and sleeve to suit wall construction.
6. Inlet: NPS 3/4
7. Outlet: NPS 1 drain connection.

C. Electrically Operated Notification Appliances:

1. Electric Bell:

a. Standard: UL 464.
b. Type: Vibrating, metal alarm bell.
c. Size: 6-inch diameter.
d. Voltage: 24 V dc.
e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."

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: 250 psig
6. Design Installation: Horizontal or vertical.

E. Pressure Switches - Water-Flow Alarm Detection:

1. Description: Electrically supervised, pressure-activated water-flow switch with retard feature.
2. Components: Two single-pole, double-throw switches with normally closed contacts.
3. Design Operation: Rising pressure to 6 psi, plus or minus 2 psi signals water flow.
4. Adjustability: Each switch is to be independently adjustable.
5. Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.

F. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Design: Signals that controlled valve is in other than fully open position.
4. Wire Terminal Designations: Indicates normal switch position when switch is properly installed on valve and valve is fully open.
5. 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.
6. OS&Y Valve Supervisory Switches:

    a. One or two single-pole, double-throw switches.
    b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
    c. Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully open.
    d. Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
    e. Trip Rod Length: Adjustable

7. Butterfly Valve Supervisory Switches:

    a. Two single-pole, double-throw switches.
    b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
    c. Mounting Hardware: Removable nipple.
    d. Trip Rod Length: Adjustable

8. Ball Valve Supervisory Switches:

    a. One single-pole, double-throw switch.
    b. NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.

c. Mounting Hardware: Suitable for mounting directly to pipe, ball valves, or backflow preventers sized from up to NPS 2

2.8 PRESSURE GAUGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gauge Range: 0 to 100 psig minimum

D. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article.

1. Flow test is to be performed to meet the criteria established by NFPA 13.
2. Flow test is to be conducted in accordance with NFPA 291.
3. Test is to be performed during a period of ordinary demand for the water system.

    a. To obtain satisfactory test results of expected flow or rated capacities, sufficient discharge should be achieved to cause drop of at least 10 percent.

4. Pitot readings are to be taken at the 2-1/2-inch orifice connection.
5. The pitot reading is to range from 10 to 35 psig
6. Open additional hydrant outlets as needed to control pitot readings.
7. The pitot pressure and corresponding residual pressure readings are to be taken consecutively as pressure fluctuates between a high number and low number.

B. Flow Test Data Written Report:

1. Flow data report is to be written in accordance with NFPA 291.
2. Flow data report is to include a copy of all flow data recorded during the test, including a site plan showing the tested fire hydrants with respect to the fire water service to the building. Site plan is to indicate which hydrant was flowed and which hydrant was used for pressure reading. Provide date of test, name of testing agency, and name of individual performing test.

C. Water Supply Curve: Provide water supply curve based on the lowest supply for a given set of test data. For a given residual pressure reading, the supply is to be graphed utilizing the corresponding pitot pressure/flow reading and static pressure reading.

D. Documentation is to include calibration certifications for gauges used in the flow tests. The certifications are to be from within the previous six (6) months from a reputable agency recognized for certifying pressure gauges.

E. Report flow test results promptly and in writing. A copy of the flow test data report is to be submitted with the hydraulic calculations.

3.2 INSTALLATION OF FIRE-SUPPRESSION WATER-SERVICE PIPING

A. Comply with requirements for fire-suppression water-service piping in Section 33 14 15 "Site Water Distribution Piping."

3.3 INSTALLATION OF FIRE-SUPPRESSION PIPING

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from AHJs. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of fire-suppression piping.

C. Install seismic restraints on piping. Comply with NFPA standards requirements for seismic-restraint device materials and installation.

D. Install 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 NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install inspector's test connections in sprinkler system piping, complete with shutoff valve, and sized and located in accordance with NFPA 13.

H. Install fire-suppression system piping with drains for complete system drainage. Extend drain piping to exterior of building where possible.

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 exterior of building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for fire-suppression piping in accordance with NFPA standards. Comply with requirements for hanger materials in NFPA standards. In seismic-rated areas, refer to Section 21 05 48 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe/sprinkler supply. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.

N. Fill wet-type fire-suppression system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 00 "Common Work Results for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 00 "Common Work Results for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 00 "Common Work Results for Fire-Suppression Piping."

3.4 INSTALLATION OF PIPING JOINTS

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 in accordance with ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.

L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

M. Brazed Joints: Join copper tube and fittings in accordance with Copper Development Association's "Copper Tube Handbook," "Brazed Joints" chapter.

N. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

O. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.

P. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. 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.

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

R. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.

3.5 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

A. Install wall-type fire department connections.

B. Install yard-type fire department connections in concrete slab support. Comply with requirements for concrete in Section 03 30 00 "Cast-in-Place Concrete."

C. Install two protective pipe bollards around each fire department connection. Comply with requirements for bollards in Section 05 50 00 "Metal Fabrications."

D. Install automatic (ball-drip) drain valve at each check valve for fire department connection.

3.6 INSTALLATION OF VALVES AND SPECIALTIES

A. Install listed fire-suppression system control valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with manufacturer's installation instructions, NFPA standards, and AHJ.

B. Install listed fire-suppression system shutoff valves in supervised open position, 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. System Control Valves:

1. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

D. Air Vent:

1. Provide at least one air vent at high point in each wet-pipe fire-suppression system in accordance with NFPA standards. Connect vent into top of fire-suppression piping.
2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
3. Pipe from outlet of air vent to drain.

3.7 INSTALLATION OF SPRINKLERS

A. Install sprinklers in suspended ceilings symmetrically in center of acoustical ceiling panels within tolerance of 1/2 inch. Coordinate entire pattern of sprinkler locations with approved reflected ceiling plan.

B. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.8 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping in accordance with requirements for identification specified in Section 21 05 53 "Identification for Fire-Suppression Piping and Equipment."

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

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Perform the following 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 fire-suppression systems in accordance with NFPA standards.
4. Energize circuits to electrical equipment and devices.
5. Start and run air compressors.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire department equipment.
9. Verify that sprinklers original factory finish has not been contaminated with dirt, debris, or paint. Sprinklers containing other-than-original factory finish are to be considered defective and replaced with new products. Repair and/or cleaning is not acceptable.

C. Fire-suppression piping system will be considered defective if it does not pass tests and inspections.

D. Fire-suppression piping system components considered defective during testing will be replaced with new components. Repair of defective components is not acceptable.

E. Prepare test and inspection reports.

3.10 CLEANING

A. Clean dirt and debris from fire-suppression system piping, system control valves, sprinklers, and associated components.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2 and Smaller, to Be One of the Following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
3. Schedule 40, black-steel pipe with cut or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.

D. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), to Be One of the Following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
5. Schedule 10, steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
6. Schedule 10, steel pipe with plain ends; welding fittings; and welded joints.

3.12 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers
2. Rooms with Suspended Ceilings: Recessed sprinklers

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Upright: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces and locations not generally exposed to view; and wax coated where exposed to acids, chemicals, or other corrosive fumes.
2. Recessed Sprinklers: Bright chrome, with bright chrome factory-painted escutcheon.

END OF SECTION

SECTION 21 11 00

FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes fire-suppression water-service piping and related components outside the building and service entrance piping through floor into the building and the following:

1. Pipes, fittings, and specialties.
2. Fire-suppression specialty valves.
3. Alarm devices.

B. Utility-furnished products include water meters that are furnished to the site, ready for installation.

C. Related Requirements:

1. Section 21 11 19 "Fire-Department Connections" for exposed-, flush-, and yard-type, fire-department connections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying the water. Include tapping of water mains and backflow prevention.
2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

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 FM Global's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-suppression water-service piping.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.

C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end.

D. Grooved-End, Ductile-Iron Pipe Appurtenances:

1. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

E. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

F. Push-on-Joint, Ductile-Iron Fittings: AWWA C153, ductile-iron compact pattern.

1. Gaskets: AWWA C111, rubber.

G. Flanges: ASME B16.1, Class 125, cast iron.

2.2 PVC PIPE AND FITTINGS

A. PVC Pipe: UL 1285 Class 150 and Class 200 with bell end with gasket, and with spigot end.

B. PVC Fittings: UL 1285 Class 150 and Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

2.3 SPECIAL PIPE FITTINGS

A. Ductile-Iron Flexible Expansion Joints:

1. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
2. Pressure Rating: 250 psig minimum.

B. Ductile-Iron Deflection Fittings:

1. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
2. Pressure Rating: 250 psig minimum.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material Linear low-density PE film of 0.008-inch minimum thickness

C. Form: Sheet or tube.

D. Color: natural

2.5 JOINING MATERIALS

A. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.6 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.
2. Standard: AWWA C219.
3. Center-Sleeve Material: Manufacturer's standard
4. Gasket Material: Natural or synthetic rubber.
5. Pressure Rating: 200 psig minimum.
6. Metal Component Finish: Corrosion-resistant coating or material.

2.7 CURB VALVES

A. Curb Valves: Comply with AWWA C800 for high-pressure, service-line valves. Valve has bronze body, ground-key plug or ball, wide tee head, and inlet and outlet matching service piping material.

B. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.

1. Shutoff Rods: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

C. Meter Valves: Comply with AWWA C800 for high-pressure, service-line valves. Include angle- or straight-through-pattern bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

2.8 DETECTOR CHECK VALVES

A. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

B. Standards: UL 312 and FM Global's "Approval Guide."

C. Pressure Rating: 175 psig (1200 kPa).

D. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2.9 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: 5 psig maximum, through middle one-third of flow range.
4. Size: 4”
5. Design Flow Rate: 6000gpm.
6. Selected Unit Flow Range Limits: 700 gpm
7. Pressure Loss at Design Flow Rate: 36 psig
8. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved
9. End Connections: Flanged.

10. Configuration: Designed for vertical inlet, and vertical outlet flow.
11. 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.

2.10 ALARM DEVICES

A. General: UL 753 and FM Global's "Approval Guide" listing, of types and sizes to mate and match piping and equipment.

B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig (1725-kPa) working pressure; designed for horizontal or vertical installation; with two single-pole, double-throw circuit switches to provide 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 when cover is removed.

C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with excavating, trenching, and backfilling requirements in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

A. Water-Main Connection: Arrange with water utility company for tap of size and in location indicated in water main.

B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

C. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.

2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

D. Comply with NFPA 24 for fire-service-main piping materials and installation.

E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

1. Install encasement for piping according to ASTM A 674 or AWWA C105.

F. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

G. Install fiberglass AWWA pipe according to AWWA M45.

H. Bury piping with depth of cover over top at least 30 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 36 inches of cover over top.
2. In Loose Gravelly Soil and Rock: With at least 12 inches of additional cover.

I. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

J. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated.

1. Terminate fire-suppression water-service piping within the building at the floor slab until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire-suppression water-service piping systems when those systems are installed.

K. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

L. Comply with requirements in Section 21 12 00 "Fire-Suppression Standpipes," Section 21 13 13 "Wet-Pipe Sprinkler Systems," for fire-suppression-water piping inside the building.

M. Comply with requirements in Section 22 11 16 "Domestic Water Piping" for potable-water piping inside the building.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of tubes and remove burrs.

C. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.

D. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

E. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with bolts according to ASME B31.9.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

H. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139.

I. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.

J. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

K. Do not use flanges or unions for underground piping.

3.4 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches in fire-suppression water-service piping according to NFPA 24 and the following:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.5 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.

E. MSS Valves: Install as component of connected piping system.

F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

G. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in Section 03 30 00 "Cast-in-Place Concrete”.

3.6 DETECTOR CHECK VALVE INSTALLATION

A. Install in aboveground.

B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.

C. Support detector check valves and piping on concrete piers. Comply with requirements for concrete piers in Section 03 30 00 "Cast-in-Place Concrete”.

3.7 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.8 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 vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 and larger backflow preventers and piping on concrete piers. Comply with requirements for concrete piers in Section 03 30 00 "Cast-in-Place Concrete."

E. Install ball drip valves at each check valve for fire-department connection to mains.

F. Install protective pipe bollards on two sides of each freestanding fire-department connection. Pipe bollards are specified in Section 05 50 00 "Metal Fabrications."

3.9 ALARM DEVICE INSTALLATION

A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.

B. Supervisory Switches: Supervise valves in open position.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Locking and Sealing: Secure unsupervised valves as follows:

1. Valves: Install chain and padlock on open OS&Y gate valve.
2. Post Indicators: Install padlock on wrench on indicator post.

D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.

E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

F. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Section 28 31 11 "Digital, Addressable Fire-Alarm System."

3.10 CONNECTIONS

A. Connect fire-suppression water-service piping to utility water main. Use tapping sleeve and tapping valve.

B. Connect fire-suppression water-service piping to interior fire-suppression piping.

3.11 FIELD QUALITY CONTROL

A. Use test procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described below.

B. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to zero psig Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Prepare test and inspection reports.

3.12 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground fire-suppression water-service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 31 20 00 "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic fire-suppression water-service piping or fire-suppression water-service piping with electrically insulated fittings, on main electrical meter panel. Comply with requirements for identifying devices in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.13 CLEANING

A. Clean fire-suppression water-service piping as follows:

1. Purge new piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

    a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow it to stand for 24 hours.
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow it to stand for three hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging activities.

3.14 PIPING SCHEDULE

A. Underground fire-suppression water-service piping NPS 4 shall be one of the following:

1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron, standard-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
4. PE, Class 150, fire-service pipe; molded PE fittings; and heat-fusion joints.
5. PVC, Class 150 pipe listed for fire-protection service; PVC fittings of same class as pipe; and gasketed joints.

B. Underground fire-suppression water-service piping NPS 6 to NPS 12 shall be one of the following:

1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
4. PE, Class 150, fire-service pipe; molded PE fittings; and heat-fusion joints.
5. PVC, Class 150 pipe listed for fire-protection service; PVC fittings of same class as pipe; and gasketed joints.

C. Aboveground fire-suppression water-service piping NPS 3 and NPS 4 shall be the following:

1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.

D. Underslab fire-suppression water-service piping NPS shall be the following:

1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
2. Mechanical-joint, ductile-iron pipe; mechanical-joint, fittings; glands, gaskets, and bolts; and restrained, gasketed joints.

3.15 VALVE SCHEDULE

A. Underground fire-suppression water-service shutoff valves NPS 3 and larger shall be of the following:

1. 200-psig (1380-kPa), AWWA, iron, nonrising-stem, resilient-seated gate valves.
2. 250-psig (1725-kPa), AWWA, iron, nonrising-stem, resilient-seated gate valves.
3. 175-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves.

B. Indicator-post underground fire-suppression water-service valves NPS 3 (DN 80) and larger shall be 175-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves with indicator-post flange.

C. Fire-suppression water-service check valves NPS 3 and larger shall be the following:

1. UL-listed and FM Global-approved check valves.

END OF SECTION

SECTION 21 11 19

FIRE DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Exposed-type fire-department connections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 - PRODUCTS

2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

A. Standard: UL 405.

B. Type: Exposed, projecting, for wall mounting.

C. Pressure Rating: 175 psig minimum.

D. Body Material: Corrosion-resistant metal.

E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

F. Caps: Brass, lugged type, with gasket and chain.

G. Escutcheon Plate: Round, brass, wall type.

H. Outlet: Back, with pipe threads.

I. Number of Inlets: Two.

J. Finish: Rough brass or bronze.

K. Outlet Size: NPS 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.

B. Examine roughing-in for fire-suppression system to verify actual locations of piping connections before fire-department connection installation.

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

3.2 INSTALLATION

A. Install wall-type fire-department connections.

B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 03 30 00 "Cast-in-Place Concrete."

C. Install two protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Section 05 50 00 "Metal Fabrications."

D. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Steel pipe and fittings.
2. Cover system for sprinkler piping.
3. Air vent.
4. Sprinkler piping specialties.
5. Sprinklers.
6. Alarm devices.
7. Manual control stations.
8. Pressure gauges.

B. Related Requirements:

1. Section 21 11 19 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 33 14 15 "Site Water Distribution Piping" for fire water-service backflow prevention devices.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data prepared by NICET Level III-certified technician, "Water-Based Systems Layout. "NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Qualification Data: For qualified Installer and NICET certified technician.

C. Design Data: Approved sprinkler piping working plans, prepared according to NFPA 13, including documented approval by authorities having jurisdiction, and including hydraulic calculations if applicable.

D. Welding certificates.

E. Field Test Reports:

1. 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."
2. Fire-hydrant flow test report.

F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 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. 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.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by NICET Level III-certified technician, "Water-Based Systems Layout."

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. Sprinkler system equipment, specialties, accessories, installation, and testing to comply with NFPA 13.

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

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Available fire-hydrant flow test records indicate the following conditions:

a. Date: 05/29/2025
b. Time: 8:32 a.m. p.m.
c. Static Pressure at Residual Fire Hydrant R: 72 psig
d. Measured Flow at Flow Fire Hydrant F:1021 gpm
e. Residual Pressure at Residual Fire Hydrant R: 620 psig The margin-of-safety requirement may not be required by authorities having jurisdiction. Retain "Margin of Safety for Available Water Flow and Pressure" Subparagraph below to require the application of a margin of safety in the Contractor's design.

2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications:

a. Electrical Equipment Rooms: Ordinary Hazard, Group 1
b. Processing, Equalization Tanks, Lab and Interior Loading Docks.: Light Hazard.
c. General Storage Areas: Ordinary Hazard, Group 1

d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1
e. Offices, including Data Processing: Light Hazard

4. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500 sq. ft.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq. ft. over 1500 sq. ft.

5. Maximum protection area per sprinkler according to UL listing.
6. 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.

E. Obtain documented approval of sprinkler system design from authorities having jurisdiction.

F. Seismic Performance: Sprinkler piping to withstand the effects of earthquake motions determined according to NFPA 13, IBC and ASCE/SEI 7See Section 21 05 48 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight Steel Pipe: black-steel pipe, ASTM A53/A53M, Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 plain end.

C. Steel Pipe Nipples: black steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.

D. Steel Couplings steel, ASTM A865/A865M, threaded.

E. Gray-Iron Threaded Fittings: 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.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 thick ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

I. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Pressure Rating: 175-psig
2. Grooved-End Fittings for Steel Piping: Uncoated grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, 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.

K. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.3 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. 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.

2.4 AIR VENT

A. Automatic Air Vent Assembly:

1. Description: Automatic air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly.
2. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler system.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: 175 psig

2.5 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee 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 and Test Assemblies:

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

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" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.

5. Inlet and Outlet: Threaded.

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

2.6 SPRINKLERS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. 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.

D. Sprinkler Finishes: Chrome plated, &bronze

E. 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

F. Sprinkler Guards:

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

2.7 ALARM DEVICES

A. Alarm-device types to 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: 8-1/2-inches diameter.
5. Components: Shaft length, bearings, and sleeve to suit wall construction.
6. Inlet: NPS 3/4
7. Outlet: NPS 1 drain connection.

C. Electrically Operated Notification Appliances:

1. Electric Bell:

a. Standard: UL 464.
b. Type: Vibrating, metal alarm bell.
c. Size: 6-inch minimum
d. Voltage: 120 V ac, 60 Hz, 1 phase or 24 V dc.
e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.

2. Strobe/Horn:

a. Standard: UL 464.
b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
c. Voltage: 120 V ac, 60 Hz.
d. Effective Intensity: 110 cd.
e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
f. Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police, or fire department.

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: 250 psig.
6. Design Installation: Horizontal or vertical.

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

2.8 PRESSURE GAUGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gauge Range: 0- to 100-psig minimum

D. Label: Include "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 33 14 15 "Site Water Distribution Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping.

C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water service.

3.3 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 22 11 16 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-distribution piping.

3.4 INSTALLATION OF PIPING

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

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

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

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 NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 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. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not 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 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "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 21 05 18 "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. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall and Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. 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.

L. 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.

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

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 NFPA 13 for supports.

3.7 INSTALLATION OF VALVES AND SPECIALTIES

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. Air Vent:

1. Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
3. Pipe from outlet of air vent to drain.

3.8 INSTALLATION OF SPRINKLERS

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. 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 26 05 53 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

A. Perform the following 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.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.12 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2 and Smaller, to Be One of the Following:

1. Standard-weight black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
3. Standard-weight black-steel pipe with cut- or roll- grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight black-steel pipe with plain ends; steel welding fittings; and welded joints.

C. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2-1/2 to NPS 4 (, to Be One of the Following:

1. Standard-weight black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Standard-weight black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. 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.
5. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers
2. Rooms with Suspended Ceilings: Recessed sprinklers

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: 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

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Motors.
2. Sleeves without waterstop.
3. Sleeves with waterstop.
4. Stack-sleeve fittings.
5. Sleeve-seal systems.
6. Grout.
7. Silicone sealants.
8. Escutcheons.
9. Thermometers, liquid in glass, lead free.
10. Thermowells, lead free.
11. Pressure gauges, dial type, lead free.
12. Gauge attachments, lead free.
13. Test plugs, lead free.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.

    a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
    b. Include operating characteristics and furnished accessories.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of gauge to include in operation and maintenance manuals.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

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

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Code Letter Designation:
    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

a. Permanent-split capacitor.
b. Split phase.
c. Capacitor start, inductor run.
d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts 120 V single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. Building Automation System Interface.

2.3 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Description: Manufactured PVC/HDPE, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Sleeve-Seal Systems:

1. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

    a. Hydrostatic Seal: 20 psig minimum.
    b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
    c. Pressure Plates: Composite plastic.
    d. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

D. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

E. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

    a. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, 25, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

    a. Standard: ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
4. Verify sealant has a VOC content of 250 g/L or less.
5. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 ESCUTCHEONS

A. Escutcheon Types:

1. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.

3. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

B. Floor Plates:

1. Split Floor Plates: Cast brass with concealed hinge.

2.5 METERS AND GAUGES FOR PLUMBING PIPING

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

1. Source Limitations: Provide liquid-in-glass, lead-free, metal-case, industrial-style thermometers from single manufacturer.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid, mercury free.
6. Tube Background: Nonreflective aluminum with permanent scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
10. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

B. Thermowells, Lead Free:

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: Lead-free copper.
4. Material for Use with Steel Piping: Type 316 stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, or as required to match threaded opening in pipe.
7. Internal Threads: Size and thread type as required to match thermometer mounting threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length to extend to match thermometer stem length.

10. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond finished insulation surface.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

C. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Metal Case:

1. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
4. Pressure-Element Assembly: Lead-free Bourdon tube.
5. Pressure Connection: Lead-free brass, with NPS 1/4, 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 permanent scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Safety glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of span.

D. Gauge Attachments, Lead Free:

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

E. Test Plugs, Lead Free:

1. Source Limitations: Provide lead-free test plugs from single manufacturer.
2. Description: Test-station fitting made for insertion into piping tee fitting.
3. Body: Lead-free brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
4. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.
5. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
6. Core Inserts: Chlorosulfonated polyethylene synthetic self-sealing rubber.

F. Test-Plug Kits, Lead Free:

1. Source Limitations: Provide lead-free test-plug kits from single manufacturer.
2. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.

3. High-Range Thermometer, Lead Free: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range is to be at least 0 to 220 deg F.
4. Pressure Gauge, Lead Free: Small, lead-free Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range is to be at least 0 to 200 psig.
5. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
3. Using grout or silicone sealant, seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

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 that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping”.

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. 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.

3.4 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.5 INSTALLATION OF METERS AND GAUGES

A. Install thermometer with thermowell at each required thermometer location.

B. Install thermowells in vertical position in piping tees.

C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

D. Install thermowells with extension on insulated piping.

E. Fill thermowells with heat-transfer medium.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

H. Install valve and snubber in piping for each pressure gauge for fluids.

I. Install test plugs in piping tees.

J. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Outlet side of hot-water-balancing valve.
3. Each main hot-water-recirculating line return pipe.

K. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each backflow preventer.
3. Suction and discharge of each domestic water pump.

3.6 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.7 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.8 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

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

3.9 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Interior Wall and Partitions:

    a. Sleeves without waterstops.

3.10 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, cast brass or split-casting brass with polished, chrome-plated finish.
3. Insulated Piping:

    a. One piece, cast brass with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One piece, cast brass with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One piece, cast brass with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

    a. One piece, cast brass with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

    a. One piece, cast brass with polished, chrome-plated finish.

3.11 THERMOMETER, LEAD FREE, APPLICATION

A. Thermometers at inlet and outlet of each domestic water heater are to be the following:

1. Metal case, industrial-style, liquid-in-glass type.
2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Thermometer stems are to be of length to match thermowell insertion length.

3.12 THERMOMETER, LEAD FREE, SCALE-RANGE APPLICATION

A. Scale Range for Domestic Cold-Water Piping:

1. 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping:

1. 0 to 250 deg F.

3.13 PRESSURE-GAUGE APPLICATION

A. Pressure gauges are to be the following:

1. Liquid filled, direct mounted, metal case.
2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

3.14 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Domestic Water Piping:

1. 0 to 100 psi.

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ball valves.
2. Check valves.
3. Gate valves.

1.3 DEFINITIONS

A. Retain terms that remain after this Section has been edited for a project. Include only essential definitions or acronyms not well understood by the affected industry or trade.

B. CWP: Cold working pressure.

C. EPDM: Ethylene propylene-diene terpolymer.

D. FKM: Fluoroelastomer.

E. NBR: Nitrile butadiene rubber (also known as Buna-N).

F. NRS: Nonrising stem.

G. OS&Y: Outside screw and yoke.

H. PTFE: Polytetrafluoroethylene.

I. RPTFE: Reinforced polytetrafluoroethylene.

J. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include material descriptions and dimensions of individual components.

b. Include operating characteristics and furnished accessories.

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, press ends, solder ends, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.
6. Set gate valves closed to prevent rattling.

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 operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic-water piping valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372; or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.

6. ASME B16.22 for wrought-copper solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves NPS 4 and larger.
2. Hand Lever: For quarter-turn ball valves smaller than NPS 4.

I. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 BALL VALVES, LEAD FREE

A. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Stainless Steel Trim:

1. Standards: MSS SP-110 and MSS SP-145.
2. CWP Rating: 600 psig.
3. Body Design: Two piece.
4. Body Material: Bronze.
5. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
6. Seats: PTFE.
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.
9. Port: Full.

B. Ball Valves - CPVC, Non-Union Type:

1. Standard: MSS SP-122.
2. Pressure Rating and Temperature: 150 psig at 73 deg F. See Part 3 ball valve schedule articles.
3. Body Material: CPVC.

4. Body Design: Non-union type.
5. End Connections: Socket or threaded.
6. Ball: CPVC, full port.
7. Seals: PTFE or EPDM-rubber O-rings.
8. Handle: Tee shaped.

C. Ball Valves, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Standard: MSS SP-110.
2. CWP Rating: 200 psig.
3. Body Design: Split body.
4. Body Material: Type 316 stainless steel.
5. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
6. Seats: PTFE.
7. Stem: Type 316 stainless steel.
8. Ball: Type 316 stainless steel.
9. Port: Full.

2.4 CHECK VALVES, LEAD FREE

A. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. Standard: MSS SP-80, Type 3.
2. CWP Rating: 200 psig.
3. Body Design: Horizontal flow.
4. Body Material: ASTM B62, bronze.
5. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
6. Disc: Bronze.

B. Check Valves, Lead Free - CPVC, Union-Type Ball Check:

1. Pressure Rating and Temperature: 150 psig at 73 deg F or other temperature. See Part 3 check valve schedule articles.
2. Body Material: CPVC.
3. Body Design: Union-type ball check.
4. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
5. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
6. Ball: CPVC.
7. Seals: EPDM- or FKM-rubber O-rings.

2.5 GATE VALVES, LEAD FREE

A. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 125:

1. Standard: MSS SP-70, Type I.
2. CWP Rating: 200 psig.
3. Body Material: Gray iron with bolted bonnet.
4. Ends: Flanged.

5. Trim: Bronze.
6. Disc: Solid wedge.
7. Packing and Gasket: Asbestos free.

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. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Install check valves for proper direction of flow and as follows:

1. Check Valves, Swing Type: In horizontal position with hinge pin level.

I. Valve Tags: Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's written recommended maximum.

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 CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Stainless Steel Piping, NPS 2 and Smaller: Threaded ends.

3.5 LOW-PRESSURE, COMPRESSED-AIR BALL VALVE SCHEDULE - 150 PSIG OR LESS

A. Pipe NPS 2 and Smaller:

1. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; threaded ends.

3.6 DOMESTIC HOT- AND COLD-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; threaded ends.

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

1. Ball Valves, Lead Free, Threaded Ends - Bronze, Three Piece with Full Port and Stainless Steel Trim.

3.7 DOMESTIC HOT- AND COLD-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; threaded ends.

3.8 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; threaded ends.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

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.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube 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 stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, 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.

2.4 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 fiberglass polyurethane or stainless steel.
3. Flammability: ASTM D635, ASTM E84, UL 94.

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.

    a. Flammability: ASTM D635, ASTM E84, UL 94.

2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.5 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Selected for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.
8. Paint Coating: Green epoxy, acrylic, or urethane.
9. Plastic Coating: PVC.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Pregalvanized G90.
8. Paint Coating: Green epoxy, acrylic, or urethane.
9. Plastic Coating: PVC.

2.6 FIBERGLASS STRUT SYSTEMS

A. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.

1. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
2. Channels: Continuous slotted fiberglass-reinforced plastic channel with in-turned lips.
3. Channel Width: Selected for applicable load criteria.
4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
6. Rated Strength: Selected to suit applicable load criteria.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.7 THERMAL HANGER-SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.8 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 anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: stainless steel.
2. Outdoor Applications: Stainless steel.

2.9 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:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

2.10 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.11 EQUIPMENT SUPPORTS

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

2.12 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, 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 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

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.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. 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 A36/A36M 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-58. 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. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

F. 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.

G. Pipe Stand Installation:

1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.

H. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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.

5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

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

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/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.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those 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, shop-painted areas on miscellaneous metal are specified in Section 09 91 23 "Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

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

B. Comply with MSS SP-58 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 finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal hanger-shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. 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 noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, 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 occurs.
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 occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
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 occurs and vertical adjustment is unnecessary.
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, in addition to expansion and contraction, is required.

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 of 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-58 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 pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

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

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve-numbering scheme.

D. Valve Schedules: For each piping system. Include in operation and 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, with predrilled or stamped holes for attachment hardware.

2. Letter and Background Color: As indicated for specific application under Part 3.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless steel rivets or self-tapping screws.
6. 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, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. 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 and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger

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

F. Fasteners: Stainless steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

A. Material: Vinyl.

B. Minimum Thickness: 0.005 inch0.005 inch (0.12 mm).

C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

E. Maximum Temperature: 160 deg F160 deg F (70 deg C).

F. Minimum Width: 2 inches2 inches (50 mm).

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.

3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.5 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.04-inch, stainless steel, 0.024-inch, aluminum, 0.031-inch or anodized aluminum, 0.031-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass link chain or beaded chain or S-hook.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. 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. Include valve-tag schedule 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: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION, GENERAL 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.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 safety-green background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft.6 ft. (2 m) of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Painting."

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Pipe-Label Locations: 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. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Low-Pressure Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
2. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
3. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
4. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
5. Sanitary Waste, Storm Drainage and Vent Piping: White letters on a black background.
6. Nonpotable Cold Water: Black letters on an ANSI Z535.1 safety-yellow background.

3.6 INSTALLATION OF VALVE TAGS

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 in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape: All services shall be 1-1/2 inches, round or square.
2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

3.7 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where indicated on Drawings.

END OF SECTION

SECTION 22 05 93

TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. TAB of domestic water system.
2. TAB of plumbing equipment:

    a. Domestic hot-water in-line circulation pumps.
    b. General-duty air compressors.
    c. Drainage pumps.

3. Pipe-leakage test verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

    a. The Contract Documents examination report.

b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. Certified TAB reports.

E. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by NEBB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.

D. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."

E. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.

F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on plumbing equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Water treatment is complete.
e. Systems are flushed, filled, and air purged.
f. Strainers are clean.
g. Control valves are functioning in accordance with the sequence of operation.
h. Shutoff and balance valves are 100 percent open.
i. Hot-water circulating pumps are operational and proper rotation is verified.
j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
k. Variable-frequency controllers' startup is complete and safeties are verified.
l. Suitable access to balancing devices and equipment is provided.

2. Sanitary Sewage/Drainage System:

a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
b. Piping is complete.
c. Sanitary sewage pumps/drainage pumps are operational.

d. Control valves are functioning in accordance with the sequence of operation.
e. Shutoff valves are 100 percent open.
f. Suitable access to equipment is provided.

3. Compressed-Air System:

a. Leakage and pressure tests on compressed air distribution system have been satisfactorily completed in accordance with Division 22 requirements.
b. Piping is complete and all points of outlet are installed.
c. Systems are flushed, filled, and air purged.
d. Strainers are clean.
e. Control valves are functioning in accordance with the sequence of operation.
f. Shutoff and balance valves are 100 percent open.
g. Compressors are operational and of proper rotation.
h. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
i. Variable-frequency controllers' startup is complete and safeties are verified.
j. Suitable access to balancing devices and equipment is provided,

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 22 07 19 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP units.

3.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Domestic water in-line pumps.

3. Domestic water heaters.
4. Drainage pumps.
5. Air compressors.

3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Check flow-control valves for proper position.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
6. Verify that motor controllers are equipped with properly sized thermal protection.
7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.6 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

A. Prepare test reports for air compressors, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:

1. Check remotest point of outlet for adequate pressure.
2. Check pressure-control valves for proper position.
3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
4. Verify that motor controllers are equipped with properly sized thermal protection.

D. Measure and record upstream and downstream pressure of pressure-reducing valves.

E. Check settings and operation of pressure-reducing valves. Record final settings.

F. Check settings and operation of each safety valve. Record settings.

3.7 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.8 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.10 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm, within 10 percent.
2. Compressed-Air Flow Rate: Plus or minus 10 percent] Plus 10 percent or minus 5 percent. If design value is less than 10 gpm10 gpm, within 10 percent.

3.11 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Model number and unit size.
    d. Manufacturer's serial number.
    e. Output capacity in Btu/h.
    f. Number of stages.
    g. Connected volts, phase, and hertz.
    h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. High-temperature-limit setting in deg F.
e. Operating set point in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water-pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.

d. Dates of use.
e. Dates of calibration.

3.13 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.

B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 20 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Sanitary waste piping exposed to freezing conditions.
5. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

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

B. Sustainable Design Submittals:

1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size, as well as ASTM standard designation and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers wit

B. h appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I for tubular materials.

G. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.

1. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL with factory-applied ASJ+ jacket.
2. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 INSULATING CEMENTS

A. Glass-Fiber Insulating Cement: Comply with ASTM C195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

C. Glass-Fiber Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Adhesive: As recommended by cellular glass manufacturer and with a VOC content of **80**; g/L or less.
2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Flexible Elastomeric Adhesive: Solvent-based adhesive.

1. Adhesive: As recommended by flexible elastomeric manufacturer and with a VOC content of 80 g/L or less.
2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
4. Wet Flash Point: Below 0 deg F.
5. Service Temperature Range: 40 to 200 deg F.
6. Color: Black.

D. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Adhesive: As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.
2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1. Verify adhesives have a VOC content of 80 g/L or less.
2. Verify adhesives and sealants comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesives and sealants comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Adhesive: As recommended by Adhesive - PVC Jacket manufacturer and with a VOC content of 50 g/L or less.
2. Verify adhesives and sealants comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesives and sealants comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
2. Verify mastics comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify mastics comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
4. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: 0 to 180 deg F.
3. Color: White.

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.6 LAGGING ADHESIVES

A. Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.

1. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of 50 g/L or less.
2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions does not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
5. Service Temperature Range: 20 to plus 180 deg F.
6. Color: White.

2.7 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.
2. Service Temperature Range: Minus 58 to plus 176 deg F.
3. Color: White or gray.
4. Verify sealant has a VOC content of 420 g/L or less.
5. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. FSK and Metal Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.

3. Color: Aluminum.
4. Verify sealant has a VOC content of 420 g/L or less.
5. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.
4. Verify sealant has a VOC content of 420 g/L or less.
5. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, 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 D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
d. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.

3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

2.12 PROTECTIVE SHIELDING GUARDS

A. 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.

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

3.2 PREPARATION

A. 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 materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents, unless otherwise approved by the engineer-of-record.

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 attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 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 Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

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 below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is 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 of same material and thickness as that 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 of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient servi ces and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

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

D. tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

E. Install removable insulation covers at locations indicated. Installation conforms 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 that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in

place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.

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

3.6 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 that of 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 sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
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 prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated 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 GLASS-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 jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with 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 prefabricated 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 glass-fiber or mineral-wool 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 prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated 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 prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF FIELD-APPLIED JACKETS

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. Seal with manufacturer's recommended adhesive.

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

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23” Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe,

three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation is the following:

a. Flexible Elastomeric: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation is the following:

a. Flexible Elastomeric: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation is one of the following:

a. Flexible Elastomeric: 3/4 inch thick.
b. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/2 and Larger: Insulation is one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed within 8 feet above finish floor:

1. Aluminum, Smooth: 0.040 inch thick.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings - domestic water.
2. CPVC piping - domestic water.
3. Piping joining materials - domestic water.
4. Transition fittings - domestic water.
5. Dielectric fittings - domestic water.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Environmental Product Declaration: For each product.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

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

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Drawn-Temper Copper Tube: ASTM B88, Type L.

B. Annealed-Temper Copper Tube: ASTM B88, Type K.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.

F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 4.

G. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.

2.4 CPVC PIPING - DOMESTIC WATER

A. Source Limitations: Obtain CPVC piping from single manufacturer.

B. CPVC Pipe: ASTM F441/F441M, with wall thickness as indicated in "Piping Applications" Article.

1. CPVC Socket Fittings: ASTM F438 for Schedule 40 and ASTM F439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F437, Schedule 80.

C. CPVC Piping System: ASTM D2846/D2846M, SDR 11, pipe and socket fittings.

D. CPVC Tubing System: ASTM D2846/D2846M, SDR 11, tube and socket fittings.

2.5 PIPING JOINING MATERIALS - DOMESTIC WATER

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 B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

1. Verify solvent cement has a VOC content of 490 g/L or less.
2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions does not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

G. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

1. Verify solvent cement has a VOC content of 510 g/L or less.
2. Verify adhesive primer has a VOC content of 550 g/L or less.
3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions does not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

4. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Verify adhesive primer complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.6 TRANSITION FITTINGS - DOMESTIC WATER

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 Couplings - Domestic Water: AWWA C219.

1. Source Limitations: Obtain sleeve-type transition couplings from single manufacturer.

D. Plastic-to-Metal Transition Fittings - Domestic Water:

1. Source Limitations: Obtain plastic-to-metal transition fittings from single source.
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 - Domestic Water:

1. Source Limitations: Obtain plastic-to-metal transition unions from single manufacturer.
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.

2.7 DIELECTRIC FITTINGS - DOMESTIC WATER

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 - Domestic Water:

1. Source Limitations: Obtain dielectric unions from single manufacturer.
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-Flange Insulating Kits - Domestic Water:

1. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Phenolic, Temperature Rating: 225 deg F.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

D. Dielectric Nipples - Domestic Water:

1. Source Limitations: Obtain dielectric nipples from single manufacturer.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

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 is to be the following:

1. Annealed-temper copper tube, ASTM B88, Type K; without joints.

D. Aboveground domestic water piping, NPS 2 and smaller is to be the following:

1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.
2. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
3. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 is to be the following:

1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.

3.2 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

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 in accordance with CDA's "Copper Tube Handbook."

C. Install valves in accordance with Section 22 05 23 "General-Duty Valves for Plumbing Piping."

D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

F. Install shut-off valve, hose-end drain valve, strainer, backflow preventer, pressure-gage, and test-tee with valve inside building at water-service entrance. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.

G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

H. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

J. Install piping to permit valve servicing.

K. 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.

L. Install piping free of sags and bends.

M. Install fittings for changes in direction and branch connections.

N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

O. Install pressure gauges on suction and discharge piping for each plumbing pump. Comply with requirements for pressure gauges in Section 22 05 00 "Common Work Results for Plumbing."

P. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23.21 "Inline, Domestic Water Pumps."

Q. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 00 "Common Work Results for Plumbing."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 00 "Common Work Results for Plumbing."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 00 "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 00 "Common Work Results for Plumbing."

3.4 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 in accordance with 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 B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

F. 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 in accordance with ASME B31.9.

G. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M.
3. PVC Piping: Join in accordance with ASTM D2855.

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

3.5 INSTALLATION OF TRANSITION FITTINGS

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.

3.6 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for copper tube and pipe, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install vinyl-coated hangers for CPVC pipe, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting.

E. Support vertical runs of copper tube and pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support vertical runs of CPVC pipe to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.10 CLEANING

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

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system in accordance with either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 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.

3.12 FIELD QUALITY CONTROL

A. 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 installation 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.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.6 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. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

B. Laboratory-Faucet Vacuum Breakers:

1. Standard: ASSE 1035.
2. Size: NPS 1/4 or NPS 3/8 matching faucet size.
3. Body: Bronze.
4. End Connections: Threaded.
5. Finish: Chrome plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.

3. Body: Bronze for NPS 2 and smaller.

4. End Connections: Threaded for NPS 2 and smaller.
5. Configuration: Designed for horizontal, straight-through flow.
6. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Hose-Connection Backflow Preventers:

1. Standard: ASSE 1052.
2. Operation: Up to 10-ft. head of water back pressure.
3. Inlet Size: NPS 3/4.
4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
5. Capacity: At least 3-gpm flow.

C. Backflow-Preventer Test Kits:

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

2.5 BALANCING VALVES

A. Automatic Flow Control Balancing Valves (Thermostatic Balance Valves):

1. The valve shall be certified lead free according to NSF/ANSI 61 standards.
2. Flow Regulation: Plus or minus 3 deg. F.
3. Pressure Rating: 200 psig.
4. Size: NPS 2 or smaller.
5. Body: Stainless steel.
6. Flow Cartridge: Stainless steel.
7. End Connections: Threaded.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Electronic, Water Mixing Valve Assemblies:

1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Type: Exposed, electronically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded or solder joint inlets and outlet.
6. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
7. Valve Finish: Bronze.
8. Digital temperature control and monitoring module.

    a. Controls temperature within plus or minus 2 deg F.
    b. User programmable at module or through BAS.

c. ASHRAE 188 compliance.
d. Local and remote monitoring.
e. BACNet protocol language(s).
f. 115 V ac, 60 Hz.
g. Battery backup.

B. Individual-Fixture, Water Tempering Valves:

1. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Material: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Connections: Threaded inlets and outlet.
6. Finish: Chrome plated.
7. Tempered-Water Setting: As required by application.
8. Tempered-Water Design Flow Rate: As required by application.

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 (DN 50) and Smaller: 0.033 inch.
b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch.

6. Drain: Pipe plug.

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 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: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.

11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 WALL HYDRANTS

A. Non-freeze Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type B.
2. Type: Automatic draining with integral air-inlet valve.
3. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
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 1/2 or NPS 3/4.
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

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.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 WATER METERS

A. Displacement-Type Water Meters:

1. Acceptable Manufacturers:

    a. Badger Meters, Inc.
    b. Xylem Sensus.

2. Standard: AWWA C700.
3. Pressure Rating: 150-psig working pressure.
4. Body Design: Nutating disc; totalization meter.
5. Registration: In gallons or cubic feet as required by utility company.

    a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

        1) System to be capable of transmitting data using AMR/AMI technology.

6. Case: Bronze.
7. End Connections: Threaded or flanged.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install 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. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

C. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

    1. Install cabinet-type units recessed in or surface mounted on wall as specified.

D. Y-Pattern Strainers: For water, install on supply side of each control valve solenoid valve and pump.

E. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Backflow preventers.
2. Balancing valves.
3. Temperature-actuated, water mixing valves.
4. Outlet boxes.
5. Wall hydrants.
6. Water meters.

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 22 05 53 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

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

C. Adjust each reduced-pressure-principle backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
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 unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 22 11 23.21

INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For pump controls.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

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. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

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. Bell & Gossett.
2. GRUNDFOS CBS Inc.
3. Taco Comfort Solutions.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Capacities and Characteristics: Shall be as indicated on plans.

D. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Minimum Working Pressure: 125 psig.
3. Maximum Continuous Operating Temperature: 220 deg F.
4. Casing: Stainless steel, with threaded or companion-flange connections.
5. Impeller: Composite or stainless steel.
6. Motor: Single speed.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 00 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V ac.
7. Settings: Start pump at 125 deg F and stop pump at 130 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 INSTALLATION OF PUMPS

A. Comply with HI 1.4.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

1. Comply with requirements for hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

D. Install thermostats in hot-water return piping.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 22 11 19 "Domestic Water Piping Specialties." Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

1. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 22 05 00 "Common Work Results for Plumbing."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.

4. Set thermostats, for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.
2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 FIELD CONDITIONS

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

1. Notify Owner no fewer than seven days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10 ft. head of water.
2. Waste, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

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

2.3 PVC PIPE AND FITTINGS

A. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

C. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F656.

1. Verify adhesive primer has a VOC content of 550 g/L or less.
2. Verify adhesive primer complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

E. Solvent Cement: ASTM D2564.

1. Verify solvent cement has a VOC content of 510 g/L or less.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

    a. Standard: ASTM C1173.
    b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. End Connections: Same size as and compatible with pipes to be joined.
    d. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
        2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
        3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

    a. Standard: ASTM C1460.
    b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. End Connections: Same size as and compatible with pipes to be joined.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

    a. Description:

        1) Standard: ASSE 1079.

        2) Pressure Rating: 125 psig minimum at 180 deg F.
        3) End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. 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.

1. 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.
2. 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.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 2-1/2 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.

M. Install aboveground PVC piping in accordance with ASTM D2665.

N. Install underground PVC piping in accordance with ASTM D2321.

O. Install force mains at elevations indicated.

P. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 22 05 00 "Common Work Results for Plumbing."

S. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 22 05 00 "Common Work Results for Plumbing."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 22 05 00 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. 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.

B. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

C. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installation are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment".

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless steel or fiberglass 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 Ft. and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Ft: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Ft. if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for PVC and CPVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

E. Support vertical runs of PVC and CPVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste 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 waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

5. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
6. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

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

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

F. Make connections in accordance with 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.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

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

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

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

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with 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.

    a. 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 waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. 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.

    a. 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.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. 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 in accordance with 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.

    a. 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.

    a. Isolate test source and allow to stand for four hours.
    b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping 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 Plastic Piping: Protect PVC plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 6 and smaller are to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, vent piping NPS 4 and smaller is to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Underground, soil, waste, and vent piping NPS 6 and smaller are to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

E. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) are to be the following:

1. Solid-wall CPVC pipe, CPVC socket fittings, and solvent-cemented joints.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Miscellaneous sanitary drainage piping specialties.

1.3 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.

B. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

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

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

A. Exposed Floor Cleanouts (FCO):

1. Standard: ASME A112.36.2M forheavy-duty, adjustable housing or threaded, adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Heavy-duty, adjustable housing or Threaded, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Threaded.
7. Closure: Plastic plug.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Extra Heavy or Medium Duty.
12. Riser: ASTM A74, Extra-Heavy or Service Class, drainage pipe fitting and riser to cleanout.

B. Wall Cleanouts (WCO):

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: PVC soil pipe test tee as required to match connected piping.
4. Closure Plug:

    a. PVC.
    b. Countersunk head.
    c. Drilled and threaded for cover attachment screw.
    d. Size: Same as or not more than one size smaller than cleanout size.

5. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.

C. Plastic Cleanouts (CO):

1. Size: Same as connected branch.
2. Body: PVC.
3. Closure Plug: PVC.
4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: PVC, with inlet and outlet matching connected piping.

2. Size: Same as connected waste piping.

    a. NPS 2: 4-inch-minimum water seal.
    b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Floor-Drain, Inline Trap Seal:

1. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
2. Material: Polymer.
3. Standard: Tested and certified in accordance with ASSE 1072.
4. Listing: ICC-ES or IAPMO listed.
5. Size: Same as floor drain outlet or strainer throat.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install heavy-duty cleanouts in traffic areas and where indicated. Install medium-duty cleanouts in all other areas.

E. Install deep-seal traps on floor drains and other waste outlets, if indicated.

F. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

G. Install wood-blocking reinforcement for wall-mounting-type specialties.

H. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. 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.

1. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 13 19.13

SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Floor drains.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Standard: ASME A112.6.3.
2. Top Loading Classification: Medium Duty.

B. Plastic Floor Drains:

1. Standard: ASME A112.6.3.
2. Material: PVC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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.
3. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 22 13 19 "Sanitary Waste Piping Specialties" for miscellaneous sanitary drainage piping specialties.

C. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. 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 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sump pumps – chemical resistant, submersible.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Sump pumps - chemical resistant, submersible.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls.

1. Indicate actual installed items by marking submittals with an arrow or box.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

1.6 WARRANTY

A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace sump pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation.
b. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: 1 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of sump pump from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.3 SUMP PUMPS - SUBMERSIBLE

A. Sump Pumps – Chemical Resistant, Submersible:

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. BJM Pumps.
b. Dayton.
c. Tsurumi Pump.

2. Description: Factory-assembled and -tested submersible chemical resistant pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
4. Pump Casing: NORYL GTX830, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.

5. Impeller: Statically and dynamically balanced, NORYL GTX830 designed for wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Type 316 Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Lower Seal: EPDM.
8. Upper Seal: EPDM.
9. Motor: Hermetically sealed, permanent split-capacitor type; with built-in overload protection; and three-conductor, waterproof direct plug-in power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: Oil.

10. Capacities and Characteristics: As indicated.
11. Controls, integral Float-Switch with type SJOOW/SOOW cord.
12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps are to be hermetically sealed.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

A. Pump Installation Standards: Comply with HI 14.4 for installation of sump pumps.

B. Wiring Method: Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 PIPING CONNECTIONS

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

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.5 ADJUSTING

A. Adjust pumps to function smoothly and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.6 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.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Pumps and controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 22 15 13

GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Piping and related specialties for general-service compressed-air systems, as follows:

1. Pipes, tubes, and fittings.
2. Joining materials.
3. Valves.
4. Dielectric fittings.
5. Flexible pipe connectors.
6. Specialties.
7. Quick couplings.
8. Hose assemblies.

B. Related Requirements:

1. Section 22 15 19 "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. HDPE: High-density polyethylene plastic.

D. High-Pressure, Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.

E. Low-Pressure, Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

F. NBR: Nitrile butadiene rubber.

G. PE: Polyethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Pipes, fittings, and valves.
2. Dielectric fittings.
3. Flexible pipe connectors.
4. Safety valves.
5. Pressure regulators. Include rated capacities and operating characteristics.
6. Automatic drain valves.
7. Filters. Include rated capacities and operating characteristics.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for high-pressure, compressed-air piping.
2. Comply with ASME B31.3, "Process Piping," for high- and low-pressure, compressed-air piping.
3. Comply with ASME B31.9, "Building Services Piping," for low-pressure, compressed-air piping.

2.3 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A53/A53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded in accordance with ASME B1.20.1.

1. Steel Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
4. Steel Flanges, Threaded: ASME B16.5, Class 150 or 300, carbon steel, threaded.
5. Wrought-Steel, Butt-Welding Fittings: ASME B16.9, Schedule 40.
6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.

B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.5 VALVES

A. Metal Ball, Butterfly, Check, and Gate Valves: Comply with requirements in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

2.6 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. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.

c. Pressure Rating: 150 psig.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.7 FLEXIBLE PIPE CONNECTORS

A. Stainless Steel-Hose Flexible Pipe Connectors: Corrugated, stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: 200 psig minimum.
2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.8 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Line Pressure Regulators, Bronze Body: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200 psig minimum inlet pressure, unless otherwise indicated.

C. Automatic Drain Valves: Stainless steel body and internal parts, rated for 200 psig minimum working pressure, capable of automatic discharge of collected condensate.

D. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated.

E. Mechanical Filters: Two-stage, mechanical-separation, air-line filters. Equip with deflector plates, resin-impregnated-ribbon filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use the following piping materials for each size range:

1. NPS 2 and Smaller, Threaded: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.

B. Low-Pressure Compressed-Air Distribution Piping: Use the following piping materials for each size range:

1. NPS 2 and Smaller, Threaded: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.

C. Drain Piping: Use the following piping materials:

1. NPS 2 and Smaller: Type M copper tube; wrought-copper fittings; and brazed or soldered joints.

3.2 VALVE APPLICATIONS

A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Article in Section 22 05 23 "General-Duty Valves for Plumbing Piping," according to the following:

1. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
2. High-Pressure Compressed Air: Valve types specified for high-pressure compressed air.
3. Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping concealed from view and protected from physical contact by building occupants, 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 otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

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

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
2. Use cast-copper-alloy companion flange with gasket and brazed or soldered joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install pressure gauge on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 22 05 00 "Common Work Results for Plumbing."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 00 "Common Work Results for Plumbing."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 00 "Common Work Results for Plumbing."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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.

D. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

E. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 INSTALLATION OF VALVES

A. General-Duty Valves: Comply with requirements in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

3.6 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 and Smaller: Use dielectric unions.

C. NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.7 INSTALLATION OF FLEXIBLE PIPE CONNECTORS

A. Install flexible pipe connectors in discharge piping of each air compressor.

B. Install stainless steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 INSTALLATION OF SPECIALTIES

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.

3.9 PIPING CONNECTIONS

A. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

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

3.10 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

B. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting and coupling.

D. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Individual, Straight, Horizontal Piping Runs:

1. 100 Ft. or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.

F. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

G. Base of Vertical Piping: MSS Type 52, spring hangers.

3.11 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.12 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four

hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Repair leaks and retest until no leaks exist.
3. Inspect filters and pressure regulators for proper operation.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 22 15 19

GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rotary-screw air compressors - oil flooded.
2. Air filters - inlet type.
3. Compressed-air aftercoolers - air cooled.
4. Compressed-air dryers - refrigerant type.
5. Computer interface cabinet.

1.3 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.

B. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.4 ACTION SUBMITTALS

A. Product Data: For each product.

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
b. Include operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings:

1. Diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For compressed-air equipment mounting.

1. Detail fabrication and assembly of supports.
2. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air equipment.

1. Indicate actual installed items by marking the submittals with an arrow or box.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Air Compressor, Inlet-Air-Filter Elements: Equal to 10 percent of amount installed, but no fewer than 2 units.
2. Belts: One for each belt-driven compressor.

1.7 COORDINATION

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.9 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace equipment that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of air compressor through one source from a single manufacturer.

2.2 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. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design compressed-air equipment mounting.

2.3 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120 V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Instrumentation: Include discharge-air pressure gauge, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gauges, and control transformer.
7. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.

C. Receivers: Steel tank constructed in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1. Pressure Rating: At least as high as highest discharge pressure of connected compressors and bearing appropriate code symbols.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: Include safety valve, pressure gauge, drain, and pressure-reducing valve.

2.4 ROTARY-SCREW AIR COMPRESSORS - OIL FLOODED

A. Rotary-Screw Air Compressors - Oil Flooded:

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. Gardner Denver, an Ingersoll Rand business.
    b. Ingersoll Rand.
    c. Quincy Compressor.

B. Compressor(s): Oil-flooded, rotary-screw type with lubricated helical screws and lubricated gear box.

1. Coupling: Nonlubricated, flexible type.
2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
3. Air Filter: Dry type, with maintenance indicator and cleanable, replaceable filter element.
4. Air/Coolant Receiver and Separation System: 150 psig rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

C. Receiver: ASME construction steel tank.

D. Enclosure: Steel with sound-attenuating material lining.

E. Capacities and Characteristics: As scheduled on drawings.

2.5 AIR FILTERS - INLET TYPE

A. Description for Each Compressor: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other methods of sound reduction.
2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.6 COMPRESSED-AIR AFTERCOOLERS - AIR COOLED

A. Description: Electric-motor-driven, fan-operation, finned-tube unit; rated at 250 psig and leak tested at 350 psig minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F above summertime maximum ambient temperature. Include moisture separator and automatic drain.

2.7 COMPRESSED-AIR DRYERS - REFRIGERANT TYPE

A. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 100 psig air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

2.8 COMPUTER INTERFACE CABINET

A. Description:

1. Wall mounting.
2. Welded steel with white enamel finish.
3. Gasketed door.
4. Grounding device.
5. Factory-installed, signal circuit boards.
6. Power transformer.
7. Circuit breaker.
8. Wiring terminal board.
9. Internal wiring capable of interfacing 20 alarm signals.

2.9 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 22 05 00 "Common Work Results for Plumbing."

1. Enclosure: Totally enclosed, fan cooled.
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of compressed air piping to verify actual location before air compressor installation.

3.2 INSTALLATION OF EQUIPMENT

A. Equipment Mounting:

1. Install air compressors, aftercoolers, and air dryers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation devices specified in Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Install compressed-air equipment anchored to substrate.

C. Arrange equipment so controls and devices are accessible for servicing.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Install the following devices on compressed-air equipment:

1. Thermometer, Pressure Gauge, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors and dryers.
3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 22 15 13 "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air compressor discharge pressure, but not higher than rating of system components.
7. Drain receiver tanks.
8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
9. Test and adjust controls and safeties.

3.8 ADJUSTING

A. Adjust equipment to function smoothly and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.9 FIELD QUALITY CONTROL

A. Test Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuity has been energized, start unit to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Air compressors, aftercoolers, air dryers, and controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors, aftercoolers, and air dryers.

END OF SECTION

SECTION 22 33 00

ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Commercial, electric, storage, domestic-water heaters.
2. Domestic-water heater accessories.

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.

B. Sustainable Design Submittals:

1. Water Heaters: Product Data for water heater compliance with ASHRAE's "Advanced Energy Design Guides."

C. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of commercial, electric, domestic-water heater.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 COORDINATION

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

1.7 WARRANTY

A. Special Warranty: 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: 1 year.

b. Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 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 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance requirements provide products indicated on drawings or approved equal.
2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: UL 1453.
4. Storage-Tank Construction: ASME-code, steel vertical arrangement.

    a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

        1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
        2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.

    b. Pressure Rating: 150 psig.
    c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Drain Valve: Corrosion-resistant metal with hose-end connection.
    c. Insulation: Comply with ASHRAE/IES 90.1.
    d. Jacket: Steel with enameled finish or high-impact composite material.
    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 working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

B. Capacity and Characteristics: As scheduled on drawings.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance requirements provide products indicated on drawings or approved equal.

2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
3. 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.
4. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.

5. Capacity and Characteristics: As scheduled on drawings.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

C. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 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 specified in Section 03 30 00 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.

4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

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 22 05 23 "General-Duty Valves for Plumbing Piping."

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 00 "Common Work Results for Plumbing."

F. Fill electric, domestic-water heaters with water.

G. Charge domestic-water expansion tanks with air to required system pressure.

H. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water to contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "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 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

1. Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training to be a minimum of one hour.

END OF SECTION

SECTION 22 42 00

COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Commercial lavatories.
2. Commercial showers.
3. Commercial sinks.
4. Commercial water closets.
5. Flushometer valves.
6. Toilet seats.
7. Fixture carriers.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PMMA: Polymethyl methacrylate; also known as "acrylic."

C. Standard-Efficiency Flush Volume: 1.6 gal. per flush.

D. High-Efficiency Flush Volume: 1.28 gal. or less per flush.

E. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for plumbing fixtures.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Plumbing Fixtures: Provide the following:

a. Manufacturer cut sheet indicating water consumption.
b. WaterSense certification for commercial water closets, commercial urinals, and commercial showers.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For lavatories and faucets.

a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1) Servicing and adjustments of automatic faucets.

2. For shower valves to include in maintenance manuals
3. For sinks and faucets to include in operation and maintenance manuals.

a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1) Servicing and adjustments of automatic faucets.

4. For flushometer valves to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials to Owner that match products installed and 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. Shower Valve Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
4. Shower Valve Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
5. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lavatory faucets, sink faucets, shower valves and faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

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.

2.2 COMMERCIAL LAVATORIES

A. Lavatories, Counter Mounted:

B. Lavatories, Wall Mounted:

1. Lavatories, Wall Mounted - Vitreous China, Rectangular with Back (L-1):

a. Provide products indicated on the drawings or approved equal.
b. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.
2) Type: As scheduled.

c. Faucet: As scheduled.

d. Support: Lavatory carrier, floor affixed with steel uprights, concealed arm.

C. Lavatory Faucets, Manually Operated:

1. Provide products indicated on the drawings or approved equal.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Additional features as scheduled.

D. Lavatory Supply Fittings:

1. NSF Standard: Comply with NSF 61 and NSF 372 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.

E. Lavatory Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
3. Trap:

a. Size: NPS 1-1/2 by NPS 1-1/4.
b. Material:

1) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.

2.3 COMMERCIAL SHOWERS

A. Shower Valve Assemblies:

1. Shower Valve Assemblies - Single-Handle, Pressure-Balanced Mixing Valve with Head (SH-1):

a. Provide products indicated on the drawings or approved equal.
b. Description: Single-handle, accessible, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and hose with handheld shower head on sliding rod shower head.
c. Shower Valve:

1) Standards:

a) ASME A112.18.1/CSA B125.1.
b) ASSE 1016/ASME A112.1016/CSA B125.16.

2) Body Material: Solid brass.
3) Additional features as scheduled.
4) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

d. Supply Connections: NPS 1/2.
e. Shower Head:

1) Standard: ASME A112.18.1/CSA B125.1.
2) EPA WaterSense: Required.

B. Grout:

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink; recommended for interior and exterior applications.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.4 COMMERCIAL SINKS

A. Service Sinks, Floor Mounted:

1. Mop Service Basins, Floor Mounted - Molded Stone (MSB-1):

a. Provide products indicated on the drawings or approved equal.
b. Source Limitations: Obtain sinks from single source from single manufacturer.
c. Fixture:

1) Standard: ASME A112.18.2/CSA B125.2.
2) Additional features as scheduled.

B. Kitchen/Utility Sinks:

1. Breakroom Sinks, Counter Mounted - Stainless Steel (SK-1):

a. Provide products indicated on the drawings or approved equal.
b. Source Limitations: Obtain sinks from single source from single manufacturer.
c. Fixture:

1) Standard: ASME A112.19.3/CSA B45.4.
2) Type: Stainless steel, self-rimming, sound-deadened unit with faucet ledge on each side.
3) Number of Compartments: One.
4) Material: 18 gauge, Type 304 stainless steel.

a) Accessible in accordance with ICC A117.1.

5) Additional features as scheduled.

d. Mounting: On counter with sealant.

2. Lab Sinks, Counter Mounted - Stainless Steel (SK-2):

a. Provide products indicated on the drawings or approved equal.
b. Source Limitations: Obtain sinks from single source from single manufacturer.
c. Fixture:

1) Standard: ASME A112.19.3/CSA B45.4.
2) Type: Stainless steel, self-rimming, sound-deadened unit with faucet ledges on each side.
3) Number of Compartments: One.
4) Material: 18 gauge, Type 304 stainless steel.
5) Accessible in accordance with ICC A117.1.
6) Additional features as scheduled.

d. Mounting: On counter with sealant.

3. Shop Sinks, Freestanding - Stainless Steel (SK-3):

    a. Provide products indicated on the drawings or approved equal.
    b. Source Limitations: Obtain sinks from single source from single manufacturer.
    c. Fixture:

        1) Standards:

            a) ASME A112.19.3/CSA B45.4.

        2) Type: Stainless steel, freestanding, sound-deadened unit with backsplash.
        3) Number of Compartments: Two.
        4) Material: 16 gauge, Type 304 stainless steel.

    d. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
    e. Additional features as scheduled.

C. Sink Faucets, Manually Operated:

1. Sink Faucets, Manually Operated

    a. Provide products indicated on the drawings or approved equal.
    b. Source Limitations: Obtain sink faucets from single source from single manufacturer.
    c. Standards:

        1) ASME A112.18.1/CSA B125.1.
        2) NSF 61.
        3) NSF 372.

    d. Description: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
    e. Additional features as scheduled.

2. Sink Faucets, Manually Operated - Service Sink:

    a. Provide products indicated on the drawings or approved equal.
    b. Source Limitations: Obtain sink faucets from single source from single manufacturer.
    c. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch hose thread end, integral vacuum breaker, inlets 8 inches o.c., and two-handle mixing.
    d. Faucet:

        1) Standards:

            a) ASME A112.18.1/CSA B125.1.
            b) NSF 61 and NSF 372.

c) ICC A117.1.
d) ASSE 1001 (VB).

2) Additional features as scheduled.

D. Sink Supply Fittings:

1. NSF Standard: Comply with NSF 61 and NSF 372 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.

E. Sink Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
3. Trap:

a. Size: NPS 1-1/2.
b. Material:

1) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

2.5 COMMERCIAL WATER CLOSETS

A. Water Closets, Wall Mounted:

1. Water Closets, Wall Mounted - Top Spud (WC-1):

a. Provide products indicated on the drawings or approved equal.
b. Source Limitations: Obtain water closets from single source from single manufacturer.
c. Standard: ASME A112.19.2/CSA B45.1.Additional features as scheduled.
d. Support: Water-closet carrier, floor affixed.

2.6 FLUSHOMETER VALVES

A. Flushometer Valves, Manually Operated:

1. Flushometer Valves, Manually Operated - Piston, Lever Handle:

a. Provide products indicated on the drawings or approved equal.
b. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
c. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.

d. Minimum Pressure Rating: 125 psig.
e. Additional features as scheduled.

2.7 TOILET SEATS

A. Toilet Seats:

1. Provide products indicated on the drawings or approved equal.
2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Standard: IAPMO/ANSI Z124.5.
4. Material: Plastic.
5. Type: Commercial (Heavy duty).
6. Shape: Elongated rim, open front.
7. Hinge: Self-sustaining, check.
8. Hinge Material: Noncorroding metal.
9. Seat Cover: Not required.
10. Color: White.
11. Surface Treatment: Not required.

2.8 FIXTURE CARRIERS

A. Fixture Carriers - Lavatory:

1. Provide products indicated on the drawings or approved equal.
2. Source Limitations: Obtain lavatory carriers from single source from single manufacturer.
3. Standards:

a. ASME A112.6.1M.
b. ASME A112.6.2.

B. Fixture Carriers - Sink:

1. Provide products indicated on the drawings or approved equal.
2. Source Limitations: Obtain sink carriers from single source from single manufacturer.
3. Standards:

a. ASME A112.6.1M.
b. ASME A112.6.2.

C. Fixture Carriers - Water Closet:

1. Provide products indicated on the drawings or approved equal.
2. Source Limitations: Obtain water closet carriers from single source from single manufacturer.
3. Standard: ASME A112.6.1M.

4. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings, gaskets, and feet; bolts and hardware matching fixture.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine walls and floors for suitable conditions where plumbing fixtures will be installed.

C. Examine counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION OF COMMERCIAL PLUMBING FIXTURES

A. Lavatory Installation:

1. Install lavatories level and plumb in accordance with roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install accessible, wall-mounted lavatories at mounting height in accordance with ICC A117.1.
4. Install water-supply piping with stop on each supply to each lavatory faucet. Install stops in locations that are accessible for ease of operation.
5. Install trap and waste piping on each drain outlet of each lavatory 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 if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 00 "Common Work Results for Plumbing."
7. Seal joints between lavatories and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

B. Shower Installation:

1. Assemble shower components in accordance with manufacturers' written instructions.
2. Install showers level and plumb in accordance with roughing-in drawings.
3. Install ball valves in water-supply piping to the shower if supply stops are specified with the shower valve. Comply with ball valve requirements specified in

Section 22 05 23 "General Duty Valves for Plumbing Piping." Install valves in locations that are accessible for ease of operation.

4. Install shower flow-control fittings with specified maximum flow rates in shower arms.
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 22 05 00 "Common Work Results for Plumbing."
6. Seal joints between showers, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

C. Sink Installation:

1. Install sinks level and plumb in accordance with roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted sinks.
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 valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23 "General Duty Valves for Plumbing Piping."
    b. Install stops/valves in locations that are accessible for ease of operation.

5. Install trap and waste piping on each drain outlet of each sink 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 if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 00 "Common Work Results for Plumbing."
7. Seal joints between sinks, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

D. Water Closet Installation:

1. Install water closets level and plumb in accordance with roughing-in drawings.
2. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.
3. Use carrier supports with waste-fitting assembly and seal.
4. Measure support height installation from finished floor, not structural floor.
5. Install flushometer-valve, water-supply fitting on each supply to each water closet.
6. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
7. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
8. Install actuators in locations easily reachable for people with disabilities.
9. Install toilet seats on water closets.

10. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Install deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 00 "Common Work Results for Plumbing."
11. Seal joints between water closets, walls, and floors using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to water-closet color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 INSTALLATION OF PIPING CONNECTIONS

A. Connect plumbing fixtures with water supplies and soil, waste, and vent piping. Use size fittings required to match plumbing fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil, waste, and vent piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

D. Install protective-shielding pipe covers and enclosures on exposed supplies and waste piping of accessible plumbing fixtures. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

E. Where installing piping adjacent to water closets and urinals, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Adjust water pressure at shower valves to produce proper flow.

D. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damages finishes. Replace any fixtures unable to be repaired to the satisfaction of the Owner.

B. Clean plumbing fixtures and associated faucets, valves, flushometer valves, and fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and associated faucets, valves, flushometer valves, and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Combination units.
2. Laboratory recessed safety station.
3. Supplemental equipment.
4. Water-tempering equipment.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.

D. Tepid: Between 60 and 100 deg F.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.

B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.

C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.

D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.

F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

G. 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 COMBINATION UNITS

A. Combination Units - Emergency Shower with Eyewash, Standard, Plumbed: (ESS-1).

1. Provide products indicated on the drawings or approved equal.
2. Source Limitations: Obtain combination units, emergency shower with eyewash, standard, plumbed, from single manufacturer.
3. Piping:

    a. Material: Galvanized steel.
    b. Unit Supply: NPS 1-1/4 minimum.
    c. Unit Drain: Outlet at back or side near bottom.

4. Shower:

    a. Capacity: Not less than 20 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull rod.
    d. Shower Head: 8-inch-minimum diameter, plastic.
    e. Mounting: Pedestal.

5. Eyewash Unit:

a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: Chrome-plated brass or stainless steel bowl.
f. Mounting: Attached shower pedestal.

6. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
c. Flow switch; single pole.
d. One-inch stainless steel ball valve.

2.3 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment - Hot and Cold Water: (TMV-2).

1. Provide products indicated on the drawings or approved equal.
2. Source Limitations: Obtain water-tempering equipment, hot and cold water, from single manufacturer.
3. Description: Factory-fabricated equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 11 16 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 22 05 00 "Common Work Results for Plumbing."

G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 22 05 00 "Common Work Results for Plumbing."

3.3 PIPING CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with

requirements for identification materials specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.8 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 47 00

DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Water coolers.
   2. Bottle filling stations.
   3. Fixture carriers.

1.3 ACTION SUBMITTALS

A. Product Data:

   1. For each type of product.

      a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
      b. Include operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

   1. Include plans, elevations, sections, and mounting details.
   2. Include details of fixture 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 wiring.

C. Sustainable Design Submittals:

   1. Product Data: For water consumption.

1.4 INFORMATIONAL SUBMITTALS

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water coolers, and bottle filling stations, to include in maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include servicing and adjustment of electronic-sensor fixtures.

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. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than one of each.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.8 WARRANTY

A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace water coolers and bottle filling stations that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation.
b. Deterioration of metals, metal finishes, and other materials beyond normal use.

B. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Drinking fountains, water coolers and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the authority having jurisdiction, and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces

2. is less than or equal to 0.25 percent.

2.2 WATER COOLERS

A. Water Coolers - Surface Wall Mounted, Vinyl-Covered Metal with Stainless Steel Top:

1. Provide products indicated on the drawings or approved equal.
2. Source Limitations: Obtain surface wall-mounted, vinyl-covered metal water coolers with stainless steel top from single source from single manufacturer.
3. Standards:

    a. NSF 61.
    b. NSF 372.
    c. ASME A112.19.3/CSA B45.4.
    d. ASHRAE 18.
    e. UL 399.
    f. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

4. Type: Vandal resistant.
5. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
6. Control: Push bar.
7. Bottle Filler: Push-button activation: Fill rate is 0.5 to 1.5 gpm.
8. Drain: Grid with NPS 1-1/4 tailpiece.
9. Supply: NPS 3/8 with shutoff valve.
10. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
11. Filter: One or more water filters with capacity sized for unit peak flow rate.

    a. Standards:

        1) NSF 42.
        2) NSF 53.

12. 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.
13. Support: Fixture carrier.
14. Capacities and Characteristics: As indicated.

2.3 FIXTURE CARRIERS

A. Fixture Carriers:

1. Provide products indicated on the drawings or approved equal.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install fixtures level and plumb in accordance with roughing-in drawings. For fixtures indicated for juveniles, install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install mounting frames, affixed to building construction, and attach recessed water coolers and bottle filling stations to mounting frames.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. 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 22 05 00 "Common Work Results for Plumbing."

G. 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 07 92 00 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture.. Install valve upstream from filter for water cooler and bottle filling station. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

C. Adjust electronic-sensor settings.

3.6 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, in accordance with manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Sleeves without waterstop.
3. Sleeves with waterstop.
4. Grout.
5. Silicone sealants.
6. Escutcheons.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.

a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
b. Include operating characteristics and furnished accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

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

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Code Letter Designation:
    a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts 120 V or 240 V single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. Circuit board or digital speed controller/LED display.
4. Building Automation System Interface: Via AC voltage signal or Digital Serial Interface (DSI).

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:

1. Description: Manufactured steel, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

C. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

D. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
   a. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component,, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.
   a. Standard: ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.3 ESCUTCHEONS

A. Escutcheon Types:

1. One-Piece, Stainless Steel Type: With polished stainless steel finish.
2. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

3. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

B. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

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 that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves.

3.3 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.4 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

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

3.5 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. Sleeves with waterstops.

4. Interior Walls and Partitions:

    a. Sleeves without waterstops.

3.6 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.

    a. Chrome-Plated Piping: One piece, cast brass with polished, chrome-plated finish in non-corrosive environments. Use one piece, stainless steel with polished stainless steel finish in corrosive environments.

2. Insulated and Bare Piping:

    a. One piece, stainless steel with polished stainless steel finish for corrosive environments.
    b. One piece, cast brass with polished, chrome-plated finish in non-corrosive environments.

B. Install floor plates for piping penetrations of equipment-room floors.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping Piping: Split floor plate.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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. Include design calculations for designing trapeze hangers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, 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.

2.4 METAL FRAMING SYSTEMS

A. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped 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 galvanized steel.
7. Paint Coating: Green epoxy, acrylic, or urethane.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or stainless steel.
2. Outdoor Applications: Stainless steel.

2.7 EQUIPMENT SUPPORTS

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

2.8 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, 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 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

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.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. 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-58. 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 A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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 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.

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.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

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

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/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.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

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

B. Comply with MSS SP-58 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 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 noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
3. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
5. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
6. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
7. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
8. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

9. 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.
10. 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.
11. 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.

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.

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. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Flow-Direction Arrows: Include flow-direction arrows. Arrows may be either integral with label or applied separately.
2. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION, GENERAL 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.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Pipe-Label Locations: 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. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation.

D. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:

a. Constant-volume air systems.
b. Variable-air-volume systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

G. UFAD: Underfloor air distribution.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.

b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB or TABB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.

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 performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate

system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Fans and ventilators.
3. Terminal units.
4. Unit heaters.

5. Condensing units.
6. Heating-only makeup air units.
7. Split-system air conditioners.
8. Heat pumps.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-hea
ting, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

6. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.

b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

a. Balance the return-air ducts and inlets.
b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:

a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
b. Re-measure and confirm that total airflow is within design.
c. Re-measure final fan operating data, speed, volts, amps, and static profile.
d. Mark final settings.
e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
f. Verify tracking between supply and return fans.

3.8 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Air pressure drop.
5. Voltage and amperage input of each phase at full load.
6. Calculated kilowatt at full load.
7. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.10 SOUND TESTS

A. After systems are balanced and Substantial Completion, measure and record sound levels at five locations as designated by the Architect.

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (L_{eq}).

3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight unweighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:

a. Location.
b. System tested.
c. dBA reading.
d. Sound pressure level in each octave band with equipment on and off.

2. Plot sound pressure levels on Noise Criteria (NC) worksheet with equipment on and off.

3.11 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.12 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.13 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify HVAC control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.14 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend

changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. Variable-frequency controller settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Apparatus-Coil Test Reports:

1. Coil Data:

    a. System identification.
    b. Location.
    c. Coil type.
    d. Number of rows.
    e. Fin spacing in fins per inch o.c.
    f. Make and model number.
    g. Face area in sq. ft..
    h. Tube size in NPS.
    i. Tube and fin materials.
    j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.

b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.

h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.

e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System fan and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.

e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.17 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Owner.

B. Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the

final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.

2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.1 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 insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type II for sheet materials.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ or FSK jacket complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, 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.

J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534 or ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

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 and Polyolefin 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 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.

2.3 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
4. Color: White.

C. Vapor-Retarder Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: 0 to 180 deg F.
3. Color: White.

D. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. 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 Vinyl and PVC Jacket Flashing Sealants:

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

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

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 ducts.

2.8 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..

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.

2. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.

a. Sheet and roll stock ready for shop or field sizing.
b. Material, finish, and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch- diameter shank, length to suit depth of insulation indicated.

2. 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 1-1/2-inch galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.12 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240/A240M, Type 304 or Type 316.

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 materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 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.
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.

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: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 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.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or

field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or

field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

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

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

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

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

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.

6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, exhaust-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Concealed, rectangular, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

D. Concealed, rectangular, return-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

E. Concealed, rectangular, outdoor-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

F. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

G. Concealed, supply-air plenum insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

H. Concealed, return-air plenum insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

I. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

J. Exposed, round and flat-oval, exhaust-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

K. Exposed, rectangular, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

L. Exposed, rectangular, return-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

M. Exposed, rectangular, outdoor-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

N. Exposed, rectangular, exhaust-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

O. Exposed, supply-air plenum insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

P. Exposed, return-air plenum insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

Q. Exposed, outdoor-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

R. Exposed, exhaust-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.

D. Ducts and Plenums, Exposed:

1. Aluminum, Stucco Embossed: 0.016 inch thick.
2. Woven Glass-Fiber Fabric.

END OF SECTION

SECTION 23 07 19

HVAC Piping Insulation

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulation for HVAC piping systems.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate: Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.

1. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. Preformed Pipe Insulation without Jacket: Type II, Class 1, without jacket.
2. Preformed Pipe Insulation with Jacket: Type II, Class 2, with factory-applied ASJ or ASJ-SSL jacket.
3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials, Type II for sheet materials.

I. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ or ASJ-SSL.
2. 850 deg F.
3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Polyisocyanurate: Preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation. Comply with ASTM C591.

1. Preformed insulation, with factory-applied ASJ or ASJ-SSL.
2. Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
3. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thicknesses of up to 1 inch as tested in accordance with ASTM E84.
4. Fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

D. Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

E. Flexible Elastomeric Adhesive: Solvent-based adhesive.

1. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
2. Wet Flash Point: Below 0 deg F.
3. Service Temperature Range: 40 to 200 deg F.
4. Color: Black.

F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

G. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

H. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

2. Service Temperature Range: 0 to plus 180 deg F.

3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
4. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: 0 to 180 deg F.
3. Color: White.

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Color: White.

2.5 LAGGING ADHESIVES

A. Adhesives shall 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. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.

a. Service Temperature Range: Minus 150 to plus 250 deg F.
b. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: Aluminum.

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. 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. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.8 FIELD-APPLIED REINFORCING MESH

A. Woven Glass-Fiber Mesh: 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 Mesh: 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 Cloth: 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 C1136, 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 D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.

2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2. Stainless Steel Jacket: ASTM A240/A240M.

a. Sheet and roll stock ready for shop or field sizing.
b. Material, finish, and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.

3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

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. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect in

B. sulation application.

C. 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 of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

D. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

E. 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 materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

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 attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

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.
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.

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 Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

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, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, 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 that of adjacent pipe insulation. Mitered

fittings shall only be used for flexible cellular insulation on pipe fitting less than 2 NPS. 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 that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. B
4. ond pieces with adhesive.
5. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
6. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable
7. reusable insulation cover. For below-ambient services, pr
8. ovide a design that maintains vapor barrier.
9. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
10. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic. Reinforce the ma
11. stic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
12. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

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

D. tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

E. 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 that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 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 ins
3. ulation and jacket.
4. 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.
5. 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.
6. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

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 that of 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 that of 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 o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of 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 that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, and same thickness as that of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as that of pipe insulation.

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF FIELD-APPLIED JACKETS

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

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

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

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

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.10 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, one location of strainers, and three locations of valves.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 3/4 inch thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Concealed:

1. None.

C. Piping, Exposed below 8 feet above finished floor:

1. PVC: 20 mils thick.

END OF SECTION

SECTION 23 09 23

DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. Bacnet: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
2. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Temperature Differential: Plus or minus 0.25 deg F.
    b. Electrical: Plus or minus 5 percent of reading.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of valves including flow characteristics.
7. DDC System Hardware:
    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
9. Controlled Systems:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

1.6 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with Bacnet.

C. Qualification Data: For Installer and manufacturer.

D. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

E. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed- air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

C. Laminated control diagram with Sequence of Operations installed next to control panel.

1.8 MAINTENANCE MATERIAL SUBMITTALS

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

contents.

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, thermostat, positioning relay.
2. Maintenance Materials: One thermostat adjusting key(s).

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

1. Installer must be familiar with Johnson Controls Metasys Building Automation and Control Systems.

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 ASHRAE 135 for DDC system components.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.11 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Simplex Fire Alarm Contractor to achieve compatibility with equipment that interfaces with that system.

C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Manufacturers:

1. Johnson Controls, Inc.; Controls Group.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.2 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
    d. Software applications, scheduling, and alarm processing.
    e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

    a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
    b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
    c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run- time totalization; and security access.
    d. Remote communications.
    e. Maintenance management.
    f. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

5. Metasys compliance.

B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup

power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. Metasys compliance

C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real- time clock. Perform automatic system diagnostics; monitor system and report failures.
3. Metasys compliance.
4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
5. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.4 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote- resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

2.5 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:

a. BEC Controls Corporation.
b. Ebtron, Inc.
c. Heat-Timer Corporation.
d. I.T.M. Instruments Inc.
e. MAMAC Systems, Inc.
f. RDF Corporation.

2. Accuracy: Plus or minus 0.5 deg F at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
5. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2- 1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Concealed.
    b. Set-Point Indication: Concealed.
    c. Thermometer: Concealed.
    d. Color: White
    e. Orientation: Vertical.

C. RTDs and Transmitters:

1. Manufacturers:

    a. BEC Controls Corporation.
    b. MAMAC Systems, Inc.
    c. RDF Corporation.

2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
5. Averaging Elements in Ducts: 24 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

    a. Set-Point Adjustment: Concealed.
    b. Set-Point Indication: Concealed.
    c. Thermometer: Concealed.
    d. Color: White
    e. Orientation: Vertical.

D. Pressure Transmitters/Transducers:

1. Manufacturers:

    a. BEC Controls Corporation.
    b. General Eastern Instruments.
    c. MAMAC Systems, Inc.
    d. ROTRONIC Instrument Corp.
    e. TCS/Basys Controls.
    f. Vaisala.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0- to 0.25-inch wg.
   d. Duct Static-Pressure Range: 0- to 5-inch wg.

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
5. Differential-Pressure Switch (Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.6 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure- differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self- powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential

adjustment, in NEMA 250, Type 1 enclosure.

1. Manufacturers:

    a. BEC Controls Corporation.
    b. I.T.M. Instruments Inc.

2.7 THERMOSTATS

A. Manufacturers:

1. Erie Controls.
2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
3. Sauter Controls Corporation.

B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

C. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

2.8 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two- position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

    a. Johnson Controls
    b. Bray Controls
    c. Belimo Aircontrols (USA), Inc.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Coupling: V-bolt and V-shaped, toothed cradle.

4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position Spring Return): 24-V ac.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: Minus 22 to plus 122 deg F.
10. Run Time: 12 seconds open, 5 seconds closed.

2.9 CONTROL VALVES

A. Manufacturers:

1. Johnson Controls; VF Series
2. Bray Controls
3. Danfoss Inc.; Air Conditioning & Refrigeration Div.
4. Magnatrol Valve Corporation.
5. Neles-Jamesbury.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 5-psig maximum pressure drop at design flow rate or the following:

    a. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field- replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Lug
2. Disc Type: Nickel-plated ductile iron or Aluminum bronze.
3. Sizing: 1-psig maximum pressure drop at design flow rate.

E. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Thermostatic Operator: Liquid-filled integral sensor with integral adjustable dial.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control.

B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices above furniture partitions approximately 72 above the floor.
1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install labels and nameplates to identify control components.

E. Install hydronic instrument wells, valves, and other accessories.

F. Install electronic and fiber-optic cables.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets.

B. Install building wire and cable.

C. Install signal and communication.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm

   proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak

checks.

2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self- contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision- resistant source.

5. Flow:

    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3- point calibration accomplished at 50, 90, and 100 percent of span.

b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Provide diagnostic and test instruments for calibration and adjustment of system.
9. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 09 23.12

CONTROL DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular control dampers with airfoil blades.
2. Round control dampers.
3. Electric and electronic control-damper actuators.

B. Related Requirements:

1. Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 23 09 93.11 "Sequence of Operations for HVAC DDC" for requirements that relate to this Section.

1.2 DEFINITIONS

A. DDC: Direct digital control.

B. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

C. Thermal Efficiency Ratio (E): Comparison of a tested damper's thermal performance against a v-groove blade reference damper. A damper with the same thermal efficiency as the reference damper would have an E value of 0 percent, while a damper that is 4 times as efficient would have an E value of 200 percent.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Rectangular control dampers with airfoil blades.
2. Round control dampers.
3. Electric and electronic control-damper actuators.

B. Product Data Submittals: For each damper and actuator.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product 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. Include diagrams for pneumatic signal and main air tubing.

D. Delegated Design Submittals:

1. Schedule and design calculations for control dampers and actuators, including the following:

a. Unique designation for each damper/actuator assembly.
b. Service/application.
c. Damper assembly size.
d. Damper assembly weight, including actuator(s).
e. Damper and actuator action (modulating or two position).
f. Flow at project design and minimum flow conditions.
g. Face velocity at project design and minimum airflow conditions.
h. Pressure drop across damper at project design and minimum airflow conditions.
i. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
j. Maximum close-off pressure.
k. Leakage airflow at maximum system pressure differential (fan close-off pressure).
l. Damper torque required at worst-case condition for sizing actuator.
m. Actuator selection indicating torque provided.
n. Actuator fail-safe position on loss of power and loss of signal.
o. Remarks listing special requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:

1. Product installation location indicated in relationship to room, duct, and equipment.

2. Size and location of wall access panels for control dampers and actuators installed behind walls.
3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control dampers.

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. ASHRAE 62.1 Compliance: Applicable outdoor ventilation requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Code Compliance: Comply with governing energy code.

E. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.

F. Backup Power Source: Serve control-damper actuators from a backup power source where associated with systems and equipment served by a backup power source.

G. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.

H. Selection Criteria:

1. Multi-Blade Damper Configuration: As follows unless otherwise indicated on Drawings:

    a. Two-Position Control: Opposed.
    b. Equipment Isolation Applications: Opposed.
    c. Outdoor/Return Air-Mixing Applications: Opposed.
    d. All Other Applications: Opposed.

2. Fail-Safe Positions: See Drawings

3. Select dampers with smooth and stable operation throughout full range of operation over varying pressures and temperatures encountered.
4. Sizing: See Drawings

2.2 RECTANGULAR CONTROL DAMPERS WITH AIRFOIL BLADES

A. General Requirements:

1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

    a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material (aluminum, galvanized steel, stainless steel) as damper frame.

2. Factory install actuator(s) as integral part of damper assembly. Coordinate, with damper manufacturer, field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements.

B. Rectangular Control Dampers with Galvanized-Steel Airfoil Blades and Frames:

1. Source Limitations: Obtain rectangular control dampers, with galvanized-steel airfoil blades and frames, from single manufacturer.
2. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
3. Performance:

    a. Leakage:

        1) AMCA 511, Class 1A, at 1 in. wg Differential Static Pressure: Leakage not to exceed 3 cfm/sq. ft. against 1 in. wg differential static pressure when tested in accordance with AMCA 500D.

    b. Pressure Drop: 0.06 in. wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500D, figure 5.3.
    c. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/180 of blade length.
    d. Temperature: Minus 40 to plus 250 deg F.
    e. Velocity: Up to 4000 fpm.

4. Construction:

    a. Frame:

        1) Material: ASTM A653/A653M galvanized steel, minimum 0.06 inch thick.
        2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 1 inch for attachment to duct flanges, plenum walls, and equipment.

3) Width: Not less than 5 inches.

b. Blades:

1) Configuration: Parallel or opposed blade configuration as required by application.
2) Material: ASTM A653/A653M galvanized steel, 0.05 inch thick.
3) Shape: Hollow, airfoil.
4) Length: As required by close-off pressure rating, not to exceed 48 inches.
5) Width: Not to exceed 8 inches.

c. Seals:

1) Blades: Replaceable; extruded silicone, vinyl, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
2) Jambs: Stainless steel, compression type.

d. Axles:

1) Diameter: Minimum 0.375 inch.
2) Material: Plated steel or stainless steel, specific to application indicated.
3) Mechanically attached to blades.

e. Bearings:

1) Material: Molded acetal or stainless steel sleeve, as required by operating conditions, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Hardware: Plated steel.
2) Material: Plated steel.
3) Mounting: Concealed in frame.

g. Transitions with Sleeve:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.

a) Sleeve length not less than 12 inches for dampers without jackshafts and not less than 16 inches for dampers with jackshafts.

b) Oversize damper and sleeve for duct connection size plus minimum 4 inches.

3) Fabricate sleeve and transitions of galvanized steel.
4) Match end connections (flange or sleeve) to field connections.

2.3 ROUND CONTROL DAMPERS

A. General Requirements:

1. Factory install actuator as integral part of damper assembly. Coordinate field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements with damper manufacturer.

B. Round, Galvanized-Steel Control Dampers with Flanged End Connections:

1. Source Limitations: Obtain round, galvanized-steel control dampers with flanged end connections from single manufacturer.
2. Performance:

a. Leakage: Not to exceed 0.15 cfm/in. of perimeter blade at 4 in. wg differential static pressure when tested in accordance with AMCA 500D.
b. Pressure Drop: 0.05 in. wg at 1500 fpm across a 12-inch damper when tested in accordance with AMCA 500D, figure 5.3.
c. Pressure Rating: 4 in. wg.
d. Temperature: Up to 250 deg F.
e. Velocity: Up to 2500 fpm.

3. Size Range: 4 to 48 inches.
4. Construction:

a. Frame:

1) Material: Galvanized steel, thickness as follows:

a) Sizes through 18 Inches in Diameter: Minimum 16 gauge thick.
b) Larger Sizes: Minimum 12 gauge thick.

2) Flanges:

a) Outward-turned flanges with bolt holes on each end of frame for mating to adjacent ductwork.
b) Face: Not less than 1-1/2 inches.
c) Thickness: Minimum 12 gauge thick.

3) Length (Flange Face to Face): Not less than 8 inches.
4) Standoff: Provide 3-inch- high, standoff for mounting actuator to axle while accommodating field-installed duct insulation.

b. Blade: Reinforced double-thickness circular flat blades sandwiched together or reinforced single-thickness circular flat blades; constructed of galvanized steel.

1) Double-Thickness Blades (Each Side):

a) Sizes through 18 Inches: Minimum 18 gauge thick.
b) Larger Sizes: Minimum 16 gauge thick.

2) Single-Thickness Blades:

a) Sizes through 36 Inches: Minimum 14 gauge thick.
b) Larger Sizes: Minimum 12 gauge thick.

c. Blade Stop: Located in airstream; galvanized steel, full-circumference bar or pin.
d. Blade Seal: EPDM, neoprene or silicone, mechanically attached to blade and fully encompassing blade edge. For double-thickness blade designs, sandwich seal between blades.
e. Axle: Continuous, plated steel, mechanically attached to blade and angle reinforced as required.

1) Blade Diameter through 24 Inches: Minimum 1/2-inch axle diameter.
2) Larger Sizes: Minimum 3/4-inch axle diameter.

f. Bearings: Bronze or stainless steel sleeve pressed into frame.

2.4 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

A. Select actuators to operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.

B. Select actuators with sufficient power and torque to close off against the maximum system pressures encountered. Actuators are to be sized to close off against the fan shutoff pressure as a minimum requirement.

C. The total damper area operated by an actuator is not to exceed 80 percent of manufacturer's maximum area rating.

D. Provide one actuator for each damper assembly where possible. Operate multiple actuators required to drive a single damper assembly in unison.

E. Avoid the use of excessively oversized actuators, which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

G. Provide mounting hardware and linkages for connecting actuator to damper.

H. Select actuators to fail-safe in desired position in the event of a power failure.

I. Actuator Fail-Safe Positions: See Drawings.

2.5 ELECTRIC AND ELECTRONIC CONTROL-DAMPER ACTUATORS

A. Source Limitations: Obtain electric and electronic control-damper actuators from single manufacturer.

B. Type: Motor operated, with or without gears, electric and electronic.

C. Voltage:

1. 120 V.
2. Actuator to deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3. Actuator to function properly within a range of 85 to 120 percent of nameplate voltage.

D. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed-steel enclosures.
2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains are to be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

E. Local Field Adjustment: Make spring-return actuators easily switchable from fail-safe open to fail-safe closed in the field without replacement.

F. Local Manual Override: Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

G. Two-Position Actuators: Single direction, spring return or reversing type.

H. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:

a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.

b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 0 to 10 or 2 to 10 V dc and 4 to 20 mA signals.
c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink, or source controller.
d. Programmable Multifunction:

1) Control input, position feedback, and running time are to be factory or field programmable.
2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
3) Service data, including at a minimum, number of hours powered and number of hours in motion.

I. Position Feedback:

1. Equip two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

J. Fail-Safe:

1. Where indicated, provide actuator to fail-safe to an end position.
2. Internal spring-return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other nonmechanical forms of fail-safe operation are acceptable only where uniquely indicated.

K. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

L. Damper Attachment:

1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and setscrew method of attachment is acceptable only if provided with at least two points of attachment.

M. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.

2. Humidity: Suitable for humidity range encountered by application; minimum operating range is to be from 5 to 95 percent relative humidity, noncondensing.

N. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 or Type 4 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. NEMA 250, Type 7 or Type 9 for hazardous applications requiring explosion-proof construction.
5. Provide actuator enclosure with a heater and controller where required by application.

O. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation, and as follows.

a. Operate damper from fully closed to fully open position within 90 seconds.
b. Operate damper from fully open to fully closed position within 90 seconds.
c. Move damper to fail-safe position within 15 seconds.

2. For actuators operating in smoke-control and other life-safety systems, comply with governing code and NFPA requirements.

P. Sound: Where actuators are located in tenant-occupied rooms with a room sound-level criteria of NC-35 or lower, comply with the following sound levels:

1. Spring Return: 45 dBA.
2. Nonspring Return: 45 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 CONTROL-DAMPER APPLICATIONS

A. Select from damper types indicated to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

B. Rectangular Control-Damper Applications:

1. Exhaust Air: Rectangular dampers with galvanized-steel airfoil blades.
2. Outdoor Air: Rectangular dampers with galvanized-steel airfoil blades.
3. Return Air: Rectangular dampers with galvanized-steel airfoil blades.
4. Supply Air: Rectangular dampers with galvanized-steel airfoil blades.

C. Round Control-Damper Applications:

1. Exhaust Air: Round galvanized-steel dampers, flange ends.
2. Outdoor Air: Round galvanized-steel dampers, flange ends.
3. Return Air: Round galvanized-steel dampers, flange ends.
4. Supply Air: Round galvanized-steel dampers, flange ends.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic, wind, or others forces common to the application.

C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Seal penetrations made in fire-rated and acoustically rated assemblies.

E. Fastening Hardware:

1. Wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

G. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

    a. Laboratory exhaust airstreams.
    b. Process exhaust airstreams.

3. Use Type 316 stainless steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 CONTROL DAMPERS

A. Install smooth transitions, not exceeding 15 degrees, to dampers larger or smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

B. Clearance:

1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access unless more space is recommended by manufacturer. Provide code required clearances as applicable.

C. Service Access:

1. Install dampers and actuators to be accessible for visual inspection and service.
2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 23 33 00 "Air Duct Accessories."

D. Install dampers straight and true, level in all planes, and square in all dimensions.

E. Install supplementary structural reinforcement for large multiple-section dampers if factory-furnished support alone cannot handle loading.

F. Attach field-installed actuator(s) to damper drive shaft.

G. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with damper identification on damper.

3.6 ELECTRICAL CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 23 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 26 28 16 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 CONTROL CONNECTIONS

A. Pneumatic Control Connections: Connect pneumatic control valve actuators and accessories to pneumatic main and signal air. Comply with requirements in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."

B. Install control signal wiring to field-mounted control devices.

C. Connect control signal wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

D. Furnish and install raceways. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems."

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 STARTUP

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Verify that control dampers are installed correctly for flow direction.
4. Verify that proper blade alignment, either parallel or opposed, has been provided.
5. Verify that damper frame attachment is properly secured and sealed.
6. Verify that damper actuator and damper linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that damper blade travel is smooth and unobstructed throughout operating range.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Valves and specialties.
4. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Strainers.
5. Filter dryers.
6. Pressure-regulating valves.
7. Mufflers.

B. Product Data Submittals: For each product.

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

C. Delegated Design Submittals: For refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Welding Certificates: For each welder performing shop or field welding on Project.

B. Field Quality-Control Reports: For each field quality control test and inspection.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

B. Prepare valves and specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads and other end connections.

C. Use the following precautions during storage:

1. Maintain valve and specialty end protection.
2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

B. Comply with ASHRAE 15.

C. Comply with ASME B31.5.

D. Test Pressure for Refrigerant R-32:

1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 300 psig.
2. Suction Tubing for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Tubing Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B88, Type K or L.

B. Wrought-Copper Fittings, Solder Joint: ASME B16.22.

C. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.

D. Wrought-Copper Unions: ASME B16.22.

E. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

F. Brazing Filler Metals: AWS A5.8M/A5.8.

G. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

H. Copper-Tube, Pressure-Seal-Joint Fittings for Refrigerant Piping:

1. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
2. Housing: Copper.
3. O-Rings: HNBR compatible with specific refrigerant.
4. Tools: Manufacturer's approved special tools.
5. Minimum Rated Pressure: 700 psig.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless steel spring.

3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

2.4 REFRIGERANTS

A. R-32, ASHRAE 34: Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

A. Refrigerant: R-32

B. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

C. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type K or Type L, drawn-temper or annealed-temper tubing and wrought-copper fittings with brazed or soldered joints

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install flexible connectors at compressors.

C. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping in accordance with ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and Section 23 09 93.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.

3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Identify refrigerant piping and valves in accordance with Section 23 05 53 "Identification for HVAC Piping and Equipment."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 00 "Common Work Results for HVAC."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 00 "Common Work Results for HVAC."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 00 "Common Work Results for HVAC."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

B. Comply with Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft. long.
2. Roller hangers and spring hangers for individual horizontal runs 20 ft. or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.
b. System must maintain test pressure at the manifold gauge throughout duration of test.
c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

C. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

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

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, in accordance with manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves but not bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Requirements:

1. Section 23 05 48 "Vibration and Seismic Controls for HVAC" for seismic restraint devices and installation.
2. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Section 23 31 16 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
4. Section 23 31 19 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
5. Section 23 33 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.

3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials

involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Sta

E. ndards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

F. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

G. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

D. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch- minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Source Limitations: Obtain fibrous-glass duct liner from single manufacturer.
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 is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Source Limitations: Obtain flexible elastomeric duct liner from single manufacturer.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

C. Fibrous-Glass-Free, Natural-Fiber Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.

1. Source Limitations: Obtain fibrous-glass-free, natural-fiber duct liner from single manufacturer.
2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

D. Polyolefin Duct Liner: Cross-linked, partially open-cell polyolefin foam sheet or roll materials, with reinforced aluminum foil facing and adhesive backing, complying with NFPA 90A or NFPA 90B; sheet (Type II) complying with ASTM C1427.

1. Source Limitations: Obtain polyolefin duct liner from single manufacturer.
2. Foam Core Density: 1.5 pcf.
3. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
4. Minimum Noise Reduction Coefficient (NRC): 0.50 for3/8-inch thickness, 0.45 for 5/8-inch thickness, 0.55 for 1-inch thickness, 0.55 for 2-1/8-inch thickness.
5. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
6. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

E. 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-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

F. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
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. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

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. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and is to be rated for10-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.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install fire and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.

9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 23 05 48 "Vibration and Seismic Controls for HVAC."

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. See Section 23 05 48 "Vibration and Seismic Controls for HVAC" for seismic restraint installation requirements.

3.6 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. New Interior Supply, Return, Outdoor, and Exhaust Ducts with Static Pressure Class above 2”WG: Test duct sections totaling no less than 100 percent of total installed duct area.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give seven days' advance notice for testing.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 23 01 30.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.10 STARTUP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

2. Ducts Connected to Constant-Volume Air-Handling Units:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

C. Return and Outdoor Air Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

3. Ducts Connected to Equipment Not Listed above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 1-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

3. Ducts Connected to Equipment Not Listed above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure; A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.

b. Not Exposed to Airstream: Galvanized.

3. Stainless Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

F. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Flange connectors.
3. Turning vanes.
4. Flexible connectors.
5. Duct accessory hardware.

B. Related Requirements:

1. Section 23 33 46 "Flexible Ducts" for insulated and non-insulated flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

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

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Performance:

a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.

2. Construction:

a. Linkage out of airstream.
b. Suitable for horizontal or vertical airflow applications.

3. Frames:

a. Hat-shaped, 16-gauge- thick, galvanized sheet steel.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized steel; 16 gauge thick.

5. Blade Axles: Galvanized steel.
6. Bearings:

a. Molded synthetic.
b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

7. Tie Bars and Brackets: Galvanized steel.
8. Locking device to hold damper blades in a fixed position without vibration.

2.3 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gauge and Shape: Match connecting ductwork.

2.4 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Fabricate 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's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

D. Vane Construction:

1. Single wall.

2.5 FLEXIBLE CONNECTORS

A. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Materials: Flame-retardant or noncombustible fabrics.

D. Coatings and Adhesives: Comply with UL 181, Class 1.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.6 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.

2.7 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

F. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

G. Install flexible connectors to connect ducts to equipment.

H. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

I. Install duct test holes where required for testing and balancing purposes.

J. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
3. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 33 46

FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flexible ducts, noninsulated.
2. Flexible ducts, insulated.
3. Flexible duct connectors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Flexible ducts, noninsulated.
2. Flexible ducts, insulated.
3. Flexible duct connectors.

B. Product Data Submittals: For each type of product.

C. Shop Drawings: For flexible ducts.

1. Include plans showing locations, mounting details, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Duct Council's (formerly, Air Diffusion Council) "ADC Flexible Air Duct Test Code - FD 72-R1" and "Flexible Duct Performance & Installation Standards."

D. Comply with ASTM E96/E96M.

2.2 FLEXIBLE DUCTS, INSULATED

A. Standard: Product is to be UL 181 listed and bearing the UL label.

B. Flexible Ducts, Insulated - Class 1, Two-Ply Vinyl Film Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Pressure Rating: 10 inch wg positive and 1.0 inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.
5. Vapor-Barrier Film: Polyethylene or Aluminized.

C. Flexible Ducts, Insulated - Class 1, Black Polymer Film Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Pressure Rating: 4 inch wg positive and 0.5 inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.
5. Vapor-Barrier Film: Polyethylene or Aluminized.

D. Flexible Ducts, Insulated - Class 1, Multiple Layers of Aluminum Laminate Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Pressure Rating: 10 inch wg positive and 1.0 inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.
5. Vapor-Barrier Film: Polyethylene or Aluminized.

E. Flexible Ducts, Insulated - Class 1, Aluminum Laminate and Polyester Film with Latex Adhesive Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:

1. Pressure Rating: 10 inch wg positive and 1.0 inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.
5. Vapor-Barrier Film: Polyethylene or Aluminized.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless steel band with stainless steel or zinc-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION OF FLEXIBLE DUCTS

A. Install flexible ducts in accordance with applicable details in the following publications:

1. ADC's "Flexible Duct Performance & Installation Standards" for flexible ducts.
2. NAIMA AH116.
3. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
4. SMACNA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.

B. Install in indoor applications only. Do not install flexible duct in locations where it will be exposed to UV lighting.

C. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

D. Connect diffusers and light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with draw bands.

F. Installation:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting must not exceed a minimum of one-duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.
6. Install in accordance with ADC instructions.

G. Supporting Flexible Ducts:

1. Support flexible duct at manufacturer's recommended intervals, but at no greater distance than 4 ft.. Provide sufficient support so that maximum centerline sag is 1/2 in. per ft. between supports. A connection to rigid duct or equipment may be considered a support joint.
2. Install extra supports at bends placed approximately one-duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports must not exceed the maximum spacing in accordance with manufacturer's written installation instructions.
4. Vertically installed ducts must be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION

SECTION 23 34 13

AXIAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tubeaxial fans.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Include rated capacities, furnished specialties, and accessories for each fan.
3. Fans:

    a. Certified fan performance curves with system operating conditions indicated.
    b. Certified fan sound-power ratings.
    c. Fan construction and accessories.
    d. Motor ratings and electrical characteristics, plus motor and electrical accessories.
    e. Fan speed controllers.

4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Seismic Qualification Data: Certificates, for fans, 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. Startup service reports.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans, include the following:

1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Capacities and Characteristics listed in schedule.

2.2 TUBEAXIAL FANS

A. Source Limitations: Obtain tubeaxial fans from single manufacturer.

B. Description: Fan wheel and housing, factory-mounted motor with direct drive, an inlet cone section, and accessories.

C. Housings: Galvanized steel with flanged inlet and outlet connections.

D. Wheel Assemblies: Cast or extruded aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

E. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan inlet allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: Horizontal ceiling clips welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
9. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
10. Backdraft Dampers: Butterfly style, for bolting to fan discharge or outlet cone, of same material as housing.
11. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to 300 deg F.
12. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
13. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation, of same material as housing.
14. Inlet Cone: Round-to-round transition, of same material as housing.
15. Outlet Cone: Round-to-round transition, of same material as housing.
16. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
17. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
18. Factory-wired motor disconnect switch located on outside of fan housing.

F. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.3 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.

B. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install axial fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install floor-mounted axial fans on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Unit Support: Install axial fans level on structural curbs. Coordinate with duct connections. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
3. Support duct-mounted and other hanging axial fans directly from the building structure, using suitable hanging systems as specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
4. Comply with requirements for vibration isolation and seismic-control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
5. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

E. Install units with adequate clearances for service and maintenance.

F. Label fans in accordance with requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "Air Duct Accessories."

B. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE:

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.

3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain axial HVAC fans.

END OF SECTION

SECTION 23 37 13.13

AIR DIFFUSERS

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. Rectangular and square ceiling diffusers.
2. Louver face diffusers.

B. Related Requirements:

1. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 23 37 13.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.
3. Section 23 37 13.43 "Security Registers and Grilles" for security registers and security grilles.
4. Section 23 37 16 "Fabric Air-Diffusion Devices" for continuous tubular diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.

C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.

D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

1.4 INFORMATIONAL SUBMITTALS

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

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Material: Steel.

B. Finish: Baked enamel, white.

C. Face Size listed in schedule.

D. Face Style listed in schedule.

E. Mounting: Surface.

F. Pattern: Fixed.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers 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 are 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 level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 37 13.23

REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fixed face registers and grilles.

B. Related Requirements:

1. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 23 37 13.13 "Air Diffusers" for various types of air diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

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

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Fixed Face Register:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
4. Face Arrangement: Perforated core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches 1 inch wide.
7. Mounting: Concealed Lay in.
8. Damper Type: Adjustable opposed blade.
9. Accessory: Filter.

2.2 GRILLES

A. Fixed Face Grille:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Horizontal; spaced 3/4 inch apart.
4. Face Arrangement: Perforated core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches 1 inch wide.
7. Mounting Frame: Filter.
8. Mounting: Concealed Lay in.
9. Accessory: Filter.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate 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 registers and grilles are 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 registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 74 33

DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dedicated outdoor air-handling units.

B. Related Requirements:

1.2 DEFINITIONS:

A. ECM: Electronically commutated motor.

B. ISCOP: Integrated Seasonal Coefficient of Performance.

C. ISMRE: Integrated Seasonal Moisture Removal Efficiency.

D. MRC: Moisture Removal Capacity.

1.3 ACTION SUBMITTALS

A. Product Data: For each dedicated outdoor-air unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include heat exchangers with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each dedicated outdoor-air unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor/roof plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force 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.

D. Startup service reports.

E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

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. Fan Belts: One set(**s**) for each belt-driven fan.
2. Filters: One set(**s**) for each unit.
3. Gaskets: One set(s) for each access door.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Dedicated Outdoor-Air-Handling Units: Three years from date of Substantial Completion.
2. Warranty Period for Compressors: Five years from date of Substantial Completion.
3. Warranty Period for Heat Exchangers: 10 years from date of Substantial Completion.
4. Warranty Period for Rotary Heat Exchangers: Five 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 an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. ASHRAE 84 Compliance: Comply with capacity ratings for heat-wheel energy-recovery equipment.

G. UL Compliance:

2.2 CAPACITIES AND CHARACTERISTICS

A. See equipment schedules on drawings.

2.3 DEDICATED OUTDOOR-AIR UNITS

A. Source Limitations: Obtain dedicated outdoor-air units from single manufacturer.

B. Unit Casing:

1. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
2. Configuration: Horizontal unit with horizontal discharge for suspended installation.
3. Double-Wall Configuration:

a. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
b. Inside Casing Wall:

1) Inside Casing, Burner Section: Galvanized steel, solid, minimum 14-gauge- thick steel.
2) Inside Casing, All Other Sections: Galvanized steel, solid.
3) Antimicrobial Coating: Applied during the manufacturing process. Coating is to be EPA approved.

c. Floor Plate: Reinforced metal surface; reinforced to limit deflection when walked on by service personnel. Insulation is provided below metal walking surface.
d. Roof: Standing seam or membrane; sloped to drain water.
e. Casing Insulation:

1) Materials: Polyurethane foam insulation.
2) Casing Panel R-Value: Minimum R-6.5.
3) Insulation Thickness: 1 inches.
4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

4. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

5. Condensate Drain Pans:

a. Location: Each refrigerant coil and rotary heat exchanger.
b. Construction:

1) Single-wall, galvanized-steel or noncorrosive polymer sheet.

c. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.
d. Drain Connection:

1) Located on one end of pan, at lowest point of pan.
2) Terminated with threaded nipple.

e. Slope: Minimum 0.125-inch/ft. slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

f. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
g. Width: Entire width of water-producing device.
h. Depth: A minimum of 2 inches deep.

i. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
j. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.

C. Fans, Drives, And Motors:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Supply-Air Fans and Relief-Air Fans: Centrifugal; galvanized or painted steel; mounted on solid-steel shaft.

a. Shafts: With field-adjustable alignment.

1) Turned, ground, and polished hot-rolled steel with keyway.

b. Shaft Bearings:

1) Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours in accordance with ABMA 9.

c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

d. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.

e. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
f. Mounting: For internal vibration isolation and seismic control. Factory mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
g. Shaft Lubrication Lines: Extended to a location outside the casing.

h. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch-thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

3. Drive, Direct: Factory-mounted direct drive.
4. Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 00 "Common Work Results for HVAC."

D. Coils:

1. General Requirements for Coils:

a. Comply with AHRI 410.
b. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
c. Coils are not to act as structural component of unit.

2. Electric-Resistance Heating Coils: Comply with UL 1995.

a. Casing Assembly: Slip-in or Flanged type with galvanized-steel frame.
b. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
c. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
d. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
e. Control Panel: Unit or Remote mounted with disconnecting means and overcurrent protection.

1) Magnetic contactor.
2) Solid-state, stepless pulse controller.
3) Toggle switches, one per step.
4) SCR controller.
5) Time-delay relay.
6) Pilot lights, one per step.
7) Airflow proving switch.

E. Air Filtration:

1. Panel Filters:

a. Description: Pleated factory-fabricated, self-supported disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
d. Filter-Media Frame: High wet-strength beverage board with perforated metal retainer, or metal grid, on outlet side.

2. Mounting Frames:

    a. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
    b. Cartridge filters arranged for flat orientation, removable from access plenum.
    c. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

F. Dampers:

1. Outdoor- and Relief-Air Dampers: Low-leakage, double-skin, airfoil-blade, dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1 inch wg and 8 cfm/sq. ft. at 4 inches wg.

2. Electronic Damper Operators:

    a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
    b. Electronic damper position indicator shall have visual scale indicating percentage of travel and 2 to 10 V dc feedback signal.
    c. Operator Motors:

        1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 00 "Common Work Results for HVAC."
        2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
        3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

    d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
    e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf.

    f. Coupling: V-bolt and V-shaped, toothed cradle.
    g. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
    h. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.

i. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2 to 10 V dc position feedback signal.
j. Temperature Rating: Minus 22 to plus 122 deg F.

G. Electrical Power Connections:

1. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.

H. Controls:

1. Comply with requirements in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and sequence of operation shown on drawings.

2. Control Wiring: Factory wire connection for controls' power supply.
3. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

4. Electric-Resistance Heat Controls:

a. Factory-mounted sensor in unit discharge with sensor adjustment located in control panel to control electric coil to maintain temperature.
b. Capacity Controls: Modulating SCR.

5. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

a. ASHRAE 135 (BACnet) communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.

I. Intake And Relief Openings:

1. Type: Manufacturer's standard hood or louver, including moisture eliminator, at all unit intake and relief openings.
2. Materials: Match material and finish of casing exterior.
3. Bird Screen: Comply with requirements in ASHRAE 62.1.
4. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.4 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.

2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Corrosion-Resistant Coating: Coat casing coils and fan guards with a corrosion-resistant coating capable of withstanding a 3,000-hour salt-spray test in accordance with ASTM B117.

2.5 SOURCE QUALITY CONTROL

A. AHRI 920: Manufacturer to certify that performance ratings are in accordance with AHRI 920 if AHRI 920 certification program is not in place. Provide AHRI 920 certification if AHRI 920 certification program is in place.

B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label unit fan sound ratings in accordance with AHRI 260 or AMCA 311.

C. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

D. Damper Leakage and Air Performance:

1. AMCA Damper Certification: Test, rate, and label in accordance with AMCA 511.

E. Refrigerant Coils: Factory tested to minimum 300 psig internal pressure and to minimum 300 psig internal pressure while under water, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

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

3.2 INSTALLATION OF DEDICATED OUTDOOR-AIR UNITS

A. Unit Support: Install unit level suspended from structural steel supports. Secure units to structural support with anchor bolts. Coordinate sizes and locations of steel supports with actual equipment provided.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

C. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

D. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 33 00 "Air Duct Accessories."

E. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

F. Comply with requirements for gas-fired furnace installation in NFPA 54.

G. Install separate devices furnished by manufacturer and not factory installed.

H. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."

2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:

    a. High-limit heat exchanger.
    b. Alarms.

3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that clearances have been provided for servicing.
5. Verify that controls are connected and operable.
6. Verify that filters are installed.
7. Clean coils and inspect for construction debris.

8. Inspect and adjust vibration isolators and seismic restraints.
9. Verify bearing lubrication.
10. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
11. Start unit.
12. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
13. Operate unit for run-in period.
14. Calibrate controls.
15. Adjust and inspect high-temperature limits.

16. Inspect outdoor-air dampers for proper stroke.
17. Verify operational sequence of controls.
18. Measure and record the following airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate, and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 CLEANING

A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3.9 DEMONSTRATION

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

END OF SECTION

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Split-system air-conditioners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

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

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

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. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.

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 Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: One year(s) from date of Substantial Completion.
b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SPLIT-SYSTEM AIR-CONDITIONERS

A. Indoor Units (5 tons (18 kW) or Less):

1. Floor-Mounted, Evaporator-Fan Components:

a. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.

1) Insulation: Faced, glass-fiber duct liner.
2) Drain Pans: Galvanized steel, with connection for drain; insulated.

b. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
c. Fan: Direct drive, centrifugal, with power-induced outside air.
d. Fan Motors:

1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 00 "Common Work Results for HVAC."
2) Multitapped, multispeed with internal thermal protection and permanent lubrication.

e. Air Filtration Section:

1) General Requirements for Air Filtration Section:

a) Comply with NFPA 90A.
b) Minimum MERV according to ASHRAE 52.2.
c) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

2. Wall-Mounted, Evaporator-Fan Components:

a. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
b. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
c. Fan: Direct drive, centrifugal.
d. Fan Motors:

1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 00 "Common Work Results for HVAC."
2) Multitapped, multispeed with internal thermal protection and permanent lubrication.
3) Enclosure Type: Totally enclosed, fan cooled.
4) NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
5) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

6) Mount unit-mounted disconnect switches on exterior of unit.

e. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
f. Condensate Drain Pans:

1) Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

a) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
b) Depth: A minimum of 1 inch deep.

2) Single-wall, galvanized-steel sheet.
3) Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
4) Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
5) Minimum Connection Size: NPS 1.
6) Pan-Top Surface Coating: Asphaltic waterproofing compound.

g. Air Filtration Section:

1) General Requirements for Air Filtration Section:

a) Comply with NFPA 90A.
b) Minimum MERV according to ASHRAE 52.2.
c) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Outdoor Units (5 tons (18 kW) or Less:

1. Air-Cooled, Compressor-Condenser Components:

a. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
b. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1) Compressor Type: Scroll.
2) Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
3) Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

c. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
d. Fan: Aluminum-propeller type, directly connected to motor.
e. Motor: Permanently lubricated, with integral thermal-overload protection.
f. Low Ambient Kit: Permits operation down to 45 deg F.
g. Mounting Base: Polyethylene.

C. Accessories

1. Control equipment and sequence of operation are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and on the drawings.
2. Thermostat:

    a. Low voltage with subbase to control compressor and evaporator fan.
    b. Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

        1) Compressor time delay.
        2) 24-hour time control of system stop and start.
        3) Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
        4) Fan-speed selection including auto setting.

3. Automatic-reset timer to prevent rapid cycling of compressor.
4. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
5. Drain Hose: For condensate.
6. Monitoring:

    a. Monitor constant and variable motor loads.
    b. Monitor cooling load.
    c. Monitor air distribution static pressure and ventilation air volumes.

D. Capacities and Characteristics

1. See equipment schedules on Drawings

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 33 00 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 23 82 39.16

PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Propeller unit heaters with electric-resistance heating coils.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. PTFE: Polytetrafluoroethylene plastic.

C. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordinated Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which propeller unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

B. Seismic Qualification Data: Submit certification that propeller unit heaters, accessories, and components will withstand seismic forces defined in Section 23 05 48 "Vibration and Seismic Controls for HVAC." Include the following:

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. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

A. Heaters: Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

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 UL 2021.

D. Comply with UL 823.

2.2 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Propeller unit heaters are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2.3 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.4 COILS

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 steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends are to be enclosed in terminal box. Fin surface temperature is not to exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
2. Wiring Terminations: Stainless steel or corrosion-resistant material.

2.5 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 23 05 00 "Common Work Results for HVAC."

2.6 CONTROLS

A. Control Devices:

1. Unitmounted, fan-speed switch.
2. Wall-mounted thermostat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION OF PROPELLER UNIT HEATERS

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Comply with safety requirements in UL 1995.

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

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

END OF SECTION

SECTION 26 00 10

SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies supplemental requirements generally applicable to the Work specified in Division 26. This Section is also referenced by related Work specified in other Divisions.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8P8C: An 8-position 8-contact modular jack.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AIC: Ampere interrupting capacity.
6. AL, Al, or ALUM: Aluminum.
7. ASD: Adjustable-speed drive; also called "variable-frequency drive" (VFD).
8. ATS: Automatic transfer switch.
9. AWG: American wire gauge; see ASTM B258.
10. BAS: Building automation system.
11. BIL: Basic impulse insulation level.
12. BIM: Building information modeling.
13. CAD: Computer-aided design or drafting.
14. CATV: Community antenna television.
15. CB: Circuit breaker.
16. cd: Candela, the SI fundamental unit of luminous intensity.
17. CO/ALR: Copper-aluminum, revised.
18. COPS: Critical operations power system.
19. CU or Cu: Copper.
20. CU-AL or AL-CU: Copper-aluminum.
21. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
22. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
23. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
24. dBm: Decibel absolute power with respect to 1 mW.
25. DC or dc: Direct current.
26. DCOA: Designated critical operations area.
27. DDC: Direct digital control (HVAC).
28. EGC: Equipment grounding conductor.

29. ELV: Extra-low voltage.
30. EMF: Electromotive force.
31. EMI: Electromagnetic interference.
32. EPM: Electrical preventive maintenance.
33. EPS: Emergency power supply.
34. EPSS: Emergency power supply system.
35. ESS: Energy storage system.
36. EV: Electric vehicle.
37. EVPE: Electric vehicle power export equipment.
38. EVSE: Electric vehicle supply equipment.
39. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
40. FLC: Full-load current.
41. ft: Foot.
42. ft-cd: Foot-candle, the antiquated U.S. Standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" after the SI unit candela (cd) replaced the international candle; see "fc,"
43. GEC: Grounding electrode conductor.
44. GFCI: Ground-fault circuit interrupter.
45. GFPE: Ground-fault protection of equipment.
46. GND: Ground.
47. HACR: Heating, air conditioning, and refrigeration.
48. HDPE: High-density polyethylene.
49. HID: High-intensity discharge.
50. HP or hp: Horsepower.
51. HVAC: Heating, ventilating, and air conditioning.
52. Hz: Hertz.
53. IBT: Intersystem bonding termination.
54. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
55. IP: Ingress protection rating (enclosures); Internet protocol (communications).
56. IR: Infrared.
57. IS: Intrinsically safe.
58. IT&R: Inspecting, testing, and repair.
59. ITE: Information technology equipment.
60. kAIC: Kiloampere interrupting capacity.
61. kcmil or MCM: One thousand circular mils.
62. kV: Kilovolt.
63. kVA: Kilovolt-ampere.
64. kVAr or kVAR: Kilovolt-ampere reactive.
65. kW: Kilowatt.
66. kWh: Kilowatt-hour.
67. LAN: Local area network.
68. lb: Pound (weight).
69. lbf: Pound (force).
70. LCD: Liquid-crystal display.
71. LCDI: Leakage-current detector-interrupter.
72. LED: Light-emitting diode.

73. Li-ion: Lithium-ion.
74. lm: Lumen, the SI derived unit of luminous flux.
75. LNG: Liquefied natural gas.
76. LP-Gas: Liquefied petroleum gas.
77. LRC: Locked-rotor current.
78. LV: Low voltage.
79. lx: Lux, the SI derived unit of illuminance equal to one lumen per square meter.
80. m: Meter.
81. MCC: Motor-control center.
82. MDC: Modular data center.
83. MG set: Motor-generator set.
84. MIDI: Musical instrument digital interface.
85. MLO: Main lugs only.
86. MV: Medium voltage.
87. MVA: Megavolt-ampere.
88. mW: Milliwatt.
89. MW: Megawatt.
90. MWh: Megawatt-hour.
91. NC: Normally closed.
92. Ni-Cd: Nickel-cadmium.
93. Ni-MH: Nickel-metal hydride.
94. NIU: Network interface unit.
95. NO: Normally open.
96. NPT: National (American) standard pipe taper.
97. OCPD: Overcurrent protective device.
98. ONT: Optical network terminal.
99. PC: Personal computer.
100. PCS: Power conversion system.
101. PCU: Power-conditioning unit.
102. PF or pf: Power factor.
103. PHEV: Plug-in hybrid electric vehicle.
104. PLC: Programmable logic controller.
105. PLFA: Power-limited fire alarm.
106. PoE: Power over Ethernet.
107. PV: Photovoltaic.
108. PVC: Polyvinyl chloride.
109. pW: Picowatt.
110. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
111. RMS or rms: Root-mean-square.
112. RPM or rpm: Revolutions per minute.
113. SCADA: Supervisory control and data acquisition.
114. SCR: Silicon-controlled rectifier.
115. SPD: Surge protective device.
116. sq.: Square.
117. SWD: Switching duty.
118. TCP/IP: Transmission control protocol/Internet protocol.
119. TEFC: Totally enclosed fan-cooled.
120. TR: Tamper resistant.
121. TVSS: Transient voltage surge suppressor.
122. UL: (standards) Underwriters Laboratories, Inc.; (product categories) UL, LLC.

123. UL CCN: UL Category Control Number.
124. UPS: Uninterruptible power supply.
125. USB: Universal serial bus.
126. UV: Ultraviolet.
127. V: Volt, unit of electromotive force.
128. V(ac): Volt, alternating current.
129. V(dc): Volt, direct current.
130. VA: Volt-ampere, unit of complex electrical power.
131. VAR: Volt-ampere reactive, unit of reactive electrical power.
132. VFC: Variable-frequency controller.
133. VOM: Volt-ohm-multimeter.
134. VPN: Virtual private network.
135. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
136. W: Watt, unit of real electrical power.
137. Wh: Watt-hour, unit of electrical energy usage.
138. WPT: Wireless power transfer.
139. WPTE: Wireless power transfer equipment.
140. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. CR: Communications raceway.
2. CR-GP: General-purpose communications raceway.
3. CR-P: Plenum communications raceway.
4. CR-R: Riser communications raceway.
5. EMT: Electrical metallic tubing.
6. EMT-A: Aluminum electrical metallic tubing.
7. EMT-S: Steel electrical metallic tubing.
8. EMT-SS: Stainless steel electrical metallic tubing.
9. ENT: Electrical nonmetallic tubing.
10. EPEC: Electrical HDPE underground conduit (thin wall).
11. EPEC-A: Type A electrical HDPE underground conduit.
12. EPEC-B: Type B electrical HDPE underground conduit.
13. ERMC: Electrical rigid metal conduit.
14. ERMC-A: Aluminum electrical rigid metal conduit.
15. ERMC-S: Steel electrical rigid metal conduit.
16. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
17. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
18. ERMC-SS: Stainless steel electrical rigid metal conduit.
19. FMC: Flexible metal conduit.
20. FMC-A: Aluminum flexible metal conduit.
21. FMC-S: Steel flexible metal conduit.
22. FMT: Steel flexible metallic tubing.
23. FNMC: Flexible nonmetallic conduit. See "LFNC."
24. HDPE: HDPE underground conduit (thick wall).
25. HDPE-40: Schedule 40 HDPE underground conduit.
26. HDPE-80: Schedule 80 HDPE underground conduit.
27. IMC: Steel electrical intermediate metal conduit.
28. LFMC: Liquidtight flexible metal conduit.
29. LFMC-A: Aluminum liquidtight flexible metal conduit.

30. LFMC-S: Steel liquidtight flexible metal conduit.
31. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
32. LFNC: Liquidtight flexible nonmetallic conduit.
33. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
34. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
35. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
36. OFR: Optical fiber raceway.
37. OFR-GP: General-purpose optical fiber raceway.
38. OFR-P: Plenum optical fiber raceway.
39. OFR-R: Riser optical fiber raceway.
40. PVC: Rigid PVC conduit.
41. PVC-40: Schedule 40 rigid PVC conduit.
42. PVC-80: Schedule 80 rigid PVC Conduit.
43. PVC-A: Type A rigid PVC concrete-encased conduit.
44. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
45. RGS: See ERMC-S-G.
46. RMC: See ERMC.
47. RTRC: Reinforced thermosetting resin conduit.
48. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
49. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
50. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
51. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
52. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.

22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.
31. MI: Mineral-insulated, metal-sheathed cable.
32. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
37. NPLF: Non-power-limited fire-alarm circuit cable.
38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
39. NPLFR: Non-power-limited fire-alarm circuit riser cable.
40. NUCC: Nonmetallic underground conduit with conductors.
41. OFC: Conductive optical fiber general-purpose cable.
42. OFCG: Conductive optical fiber general-purpose cable.
43. OFCP: Conductive optical fiber plenum cable.
44. OFCR: Conductive optical fiber riser cable.
45. OFN: Nonconductive optical fiber general-purpose cable.
46. OFNG: Nonconductive optical fiber general-purpose cable.
47. OFNP: Nonconductive optical fiber plenum cable.
48. OFNR: Nonconductive optical fiber riser cable.
49. P: Marine shipboard cable.
50. PLTC: Power-limited tray cable.
51. PLTC-ER: Power-limited tray cable, exposed run.
52. PV: Photovoltaic cable.
53. RHH: (high heat) Thermoset rubber, heat-resistant cable.
54. RHW: Thermoset rubber, moisture-resistant cable.
55. SA: Silicone rubber cable.
56. SE: Service-entrance cable.
57. SER: Service-entrance cable, round.
58. SEU: Service-entrance cable, flat.
59. SIS: Thermoset cable for switchboard and switchgear wiring.
60. TBS: Thermoplastic cable with outer braid.
61. TC: Tray cable.
62. TC-ER: Tray cable, exposed run.
63. TC-ER-HL: Tray cable, exposed run, hazardous location.
64. THW: Thermoplastic, heat- and moisture-resistant cable.
65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
66. THHW: Thermoplastic, heat- and moisture-resistant cable.
67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
68. TW: Thermoplastic, moisture-resistant cable.
69. UF: Underground feeder and branch-circuit cable.

70. USE: Underground service-entrance cable.
71. XHH: Cross-linked polyethylene, heat-resistant cable.
72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."

    a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.

2. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
3. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
4. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
5. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
6. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
7. Designated Seismic System: A system component that requires design in accordance with Ch. 13 of ASCE/SEI 7 and for which the Component Importance Factor is greater than 1.0.
8. Direct Buried: Installed underground without encasement in concrete or other protective material.
9. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Concrete Box: A box intended for use in poured concrete.
    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or

terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.

e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.

f. Device Box: A box with provisions for mounting a wiring device directly to the box.

g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.

h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.

i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.

j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.

k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.

l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.

m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.

n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.

o. Raised-Floor Box: A floor box intended for use in raised floors.

p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.

q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.

r. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.

s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.

t. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

10. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
11. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
12. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.

    a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.

13. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
14. Jacket: A continuous nonmetallic outer covering for conductors or cables.
15. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
16. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
17. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
18. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
19. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
20. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
21. Sheath: A continuous metallic covering for conductors or cables.
22. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
23. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.

b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

24. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.3 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.
3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:

a. Emergency lighting.
b. Fire-alarm systems.

B. Arrange to provide temporary electrical service or power in accordance with requirements specified in Division 01.

1.4 PREINSTALLATION MEETINGS

A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than 10 days after notice to proceed. Agenda topics include, but are not limited to, the following:

1. Electrical installation schedule.
2. Status of power system studies.
3. Value analysis proposals and requests for substitution of electrical equipment.
4. Utility work coordination and class of service requests.
5. Commissioning activities.
6. Sustainability activities.

1.5 SEQUENCING

A. Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

1.6 ACTION SUBMITTALS

A. Coordination drawings.

1.7 INFORMATIONAL SUBMITTALS

A. Electrical installation schedule.

B. Qualification statements.

1.8 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.9 QUALITY ASSURANCE

A. Qualifications: Prepare and submit qualification statements for the following entities performing Work on Project:

1. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 01 40 00 "Quality Requirements," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.
2. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," with expertise in structural engineering.
3. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.
4. Lighting Professional Engineer: Professional engineer possessing active qualifications in accordance with Section 01 40 00 "Quality Requirements" and the following:

a. Expertise in electrical engineering, lighting design, and structural requirements for exterior poles and standards.
b. Lighting Certified (LC) Professional by the National Council on Qualifications for the Lighting Professions (NCQLP).

5. EPM Specialist: Recognized experts possessing the following qualifications in accordance with Section 01 40 00 "Quality Requirements" and NFPA 70B:

a. Technical Competence: Person should, by education, training, and experience, be well-rounded in all aspects of electrical maintenance.
b. Administrative and Supervisory Skills: Person should be skilled in planning and development of long-range objectives to achieve specific results and should be able to command respect and solicit cooperation of persons involved in EPM Program development.

6. Welder: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," with training and certification in accordance with AWS D1.1/D1.1M.
7. ERMC-S-PVC Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present unexpired certified Installer credentials issued by ERMC-S-PVC manufacturer prior to starting installation.
8. Medium-Voltage Cable Installer: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate medium-voltage cable in accordance with electrical utility service provider's requirements.

9. Medium-Voltage Duct Installer: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" with documented training and experience with installation of medium-voltage duct banks in accordance with electrical utility service provider's requirements.

10. Medium-Voltage Equipment Installer: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" with documented training and experience with hazards and safety requirements associated with installation and operation of medium-voltage equipment in accordance with electrical utility service provider requirements.

11. Electrical Power Monitoring Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.
12. EVSE Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present unexpired certified Installer credentials issued by EVSE manufacturer prior to starting installation.
13. Generator Set Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present unexpired certified Installer credentials issued by generator set manufacturer prior to starting installation.
14. Lightning Protection System Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present

unexpired UL-Listed Installer, UL Category Control Number OWAY, credentials prior to starting installation.

15. Theatrical Lighting Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present unexpired certified Installer credentials issued by theatrical lighting manufacturers prior to starting installation.
16. Exterior Athletic Lighting Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present unexpired certified Installer credentials issued by exterior athletic lighting manufacturer prior to starting installation.
17. Power Quality Specialist: Recognized experts possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction, and able to present unexpired NICET Level 4 credentials with documented experience in power quality testing for installations similar in complexity to this Project.
18. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

    a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

19. Medium-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

    a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

20. Power-Limited Electrical Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

    a. On-site power-limited testing supervisor must have BICSI Registered Communications Distribution Designer certification and documented training and experience with testing power-limited equipment in accordance with NETA testing standards.

21. Structural Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" with documented training and experience with testing structural concrete, seismic controls, and wind-load controls.
22. Outdoor Pole Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" with documented training and experience in accordance with ASTM C1093 for foundation testing and inspections.
23. Luminaire Photometric Testing Laboratory: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" accredited under the

NVLAP for Energy Efficient Lighting Products, and complying with applicable IES testing standards.

24. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with IES LM-5.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Notification of Contractor's intent to request substitutions for convenience must be declared during the Electrical Preconstruction Conference so potential risks to system performance and construction schedule may be identified for Contractor's response in submission of the substitution request. Submission of requests for substitutions for convenience must meet the conditions and deadline specified in Section 01 25 00 "Substitution Procedures" to receive approval.
2. For electrical equipment and systems, substitutions for cause are considered major construction risks. If it is possible that Contractor may need to request substitutions for cause because of equipment unavailability, or inability to meet construction schedule because of lead time, Contractor must declare the possibility during the Electrical Preconstruction Conference to permit establishing a mitigation plan for minimizing risks to system performance and construction schedule.

PART 3 - EXECUTION

3.1 PREPARATION

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 26.
4. Orders placed for major electrical equipment.
5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Utility service outages.
8. Utility service inspection and activation.
9. Mockup reviews.
10. Closing of walls and ceilings containing electrical Work.

11. System startup, testing, and commissioning activities for major electrical equipment.
12. System startup, testing, and commissioning activities for emergency lighting.
13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

B. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.

C. Coordination Drawings for Ceiling Areas: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 01 31 00 "Project Management and Coordination," 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. Structural members to which equipment, luminaires, and suspension systems will be attached.
3. Partitions and millwork that penetrate ceiling or extend to within 12 inch (300 mm) of plane of luminaires.
4. Size and location of access panels on ceilings.
5. Elevation, size, and route of sprinkler piping.
6. Elevation, size, and route of plumbing piping.
7. Elevation, size, and route of ductwork.
8. Elevation, size, and route of cable tray.
9. Elevation, size, and route of conduit.
10. Elevation and size of wall-mounted and ceiling-mounted equipment.
11. Moldings.
12. Access panels.
13. Sprinklers.
14. Air inlets and outlets.
15. Control modules.
16. Luminaires.
17. Communications devices.
18. Speakers.
19. Ceiling-mounted projectors.
20. Security devices.
21. Fire-alarm devices.
22. Indicate clear dimensions for maintenance access in front of equipment.
23. Indicate dimensions of fully-open access doors.

D. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 01 31 00 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Elevation, size, and route of cable trays.
2. Relationships between components and adjacent structural, electrical, and mechanical elements.
3. Vertical and horizontal offsets and transitions.
4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
5. Elevation of ceilings and size of ceiling tiles.
6. Locations of access panels on ceilings.
7. Locations where cable tray crosses or parallels sprinkler piping.
8. Locations where cable tray crosses plumbing piping.
9. Locations where cable tray crosses or parallels ductwork.
10. Locations of access panels on ductwork.
11. Locations where cable tray crosses conduit.
12. Items blocking access around cable trays, including the following:

    a. Light fixtures.
    b. Speakers.
    c. Fire-alarm devices.
    d. Power outlets.
    e. Wall-mounted equipment.
    f. Equipment racks.
    g. Furniture.
    h. Door swings.
    i. Building features.

13. Indicate clear dimension between cable tray and walls or obstructions that are closer than 10 ft (3 m).
14. Highlight locations where cable tray is greater than 3 ft (1 m) above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.

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

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

F. Coordination Drawings for Duct Banks:

1. Show duct profiles and coordination with other utilities and underground structures.
2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

3.2 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

3.3 FIELD QUALITY CONTROL

A. Administrant for Medium-Voltage Electrical Tests and Inspections:

1. Owner will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Administrant for Low-Voltage Electrical Tests and Inspections:

1. Owner will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

C. Administrant for Structural Tests and Inspections:

1. Owner will engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified structural testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

D. Administrant for Field Tests and Inspections of Lighting Installations:

1. Owner will engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

END OF SECTION

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cables.
2. Separable insulated connectors.
3. Splice kits.
4. Medium-voltage tapes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include separable insulated connectors and cable accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type of cable, connector, and accessory.

B. Source quality-control reports.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 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 IEEE C2 and NFPA 70.

C. Source Limitations: Obtain each type of cable, connector, and accessories from single source from single manufacturer.

2.2 CABLES

A. Cable Type: Type MV 105, suitable for URD applications.

B. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 15 kV.
2. Insulation Thickness: 133 percent insulation level.

C. Conductor: Copper or Aluminum.

D. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.

E. Conductor Stranding: Compact round, concentric lay, Class B.

F. Strand Filling: non-hygroscopic moisture-blocking compound, specifically for 15kV cables and designed to last the life of the cable.

G. Shielding: Semiconducting extruded thermosetting insulation shield with controlled adhesion to insulation providing ideal balance between electrical integrity and ease of stripping.

H. Concentric Neutral: 1/3 concentric neutral, copper wires helically applied and uniformly spaced over insulation shield.

I. Cable Jacket: Sunlight-resistant PVC, 80 mils minimum thickness.

2.3 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Load-Break Cable Terminators: Elbow-type units with 200 A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

2.4 SPLICE KITS

A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.

B. Standard: Comply with IEEE 404.

C. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions. Provide kit of one of the following types.
   1. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
   2. Premolded, cold-shrink-rubber, in-line splicing kit.

2.5 MEDIUM-VOLTAGE TAPES

A. Description: Electrical grade, insulating tape rated for medium voltage application.

B. Ethylene/propylene rubber-based, 30 mil (0.76 mm) splicing tape, rated for 130 deg C operation. Minimum 3/4 inch (20 mm) wide.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-94-649 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inch (1200 to 1800 mm) on the pull rope.

   1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
   2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

   1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

F. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

G. Avoid cable splices. If splices are deemed necessary, install only with written authorization from owner at accessible pull points using standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.

H. Seal around cables passing through fire-rated elements according to Section 07 84 13 "Penetration Firestopping."

I. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

J. Ground shields/neutrals of shielded cable. Maintain shield/neutral continuity and connections to metal connection hardware at all connection points.

K. Identify cables according to Section 26 05 53 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.

B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Connectors and splices.

B. Related Requirements:

1. Section 26 05 13 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35 000 V.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Copper building wire.
2. Connectors and splices.

B. Product Schedule: Indicate type and use.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

D. Conductor Insulation:
1. Type THHN and Type THWN-2. Comply with UL 83.

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: One hole with standard barrels.
3. Termination: Crimp.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Branch Circuits:

1. Copper:

a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Power-Limited Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

3.3 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points in accordance with Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

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

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to manufacturer's instructions.

3.7 FIELD QUALITY CONTROL

A. 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 of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports 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.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connector.
7. Grounding and bonding busbars.
8. Signal reference grids.
9. Grounding (earthing) electrodes.
10. Grounding electrode enclosures.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 00 11 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
3. Section 26 41 13 "Lightning Protection for Structures" specifies bonding of lightning protection grounding electrodes to facility grounding electrodes.
4. Section 27 05 28 "Pathways for Communications Systems" specifies additional requirements for grounding and bonding of communications raceways, boxes, and cable trays.
5. Section 27 11 00 "Communications Equipment Room Fittings" specifies additional requirements for grounding and bonding of communications equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding of Electrical Power" Article, including the following:

1. Grounding electrode access enclosures.
2. Grounding electrodes.
3. Grounding arrangements and connections for separately derived systems.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 26 00 10 "Supplemental Requirements for Electrical," include the following:

a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding of Electrical Power" Article, including the following:

1) Grounding electrode access enclosures.
2) Grounding electrodes.
3) Grounding arrangements and connections for separately derived systems.

b. Instructions for periodic testing and inspection of grounding features at test wells, ring electrodes, and grounding connections for separately derived systems based on NFPA 70B.

1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
2) Include recommended testing intervals.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color, in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color with one or more yellow stripes, in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. ASTM - Bare Copper Grounding and Bonding Conductor:
1. Referenced Standards: Complying with one or more of the following:

a. Soft or Annealed Copper Wire: ASTM B3.
b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

D. UL KDER - Armored Grounding Wire:

1. Description: Single corrosion-resistant copper, aluminum, or copper-clad aluminum conductor within helically formed steel armor.
2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

E. UL KDSH - Protector Grounding Conductor:

1. Description: Conductors intended to be used for grounding primary protector or metallic members of cable sheath in accordance with Chapters 7 and 8 of NFPA 70.
2. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. Listing Criteria:

a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

4. Options:

a. Color: green.

2.2 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

3. Sustainability Characteristics:

D. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:

1. General Characteristics:

a. Two pieces with zinc-plated bolts.
b. Clamp Material: Die-cast zinc alloy.
c. Listed for outdoor use.

E. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp:

1. General Characteristics:

a. Clamp Material: Aluminum.
b. Listed for outdoor use.

F. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp:

1. General Characteristics:

a. Clamp Material: Aluminum.
b. Listed for outdoor use.

G. UL KDER - Beam Grounding and Bonding Clamp:

1. General Characteristics: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.

H. UL KDER - Exothermically Welded Connection:

1. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

I. UL KDER - Raised-Floor Signal Reference Grid Clamp:

1. General Characteristics: Mechanical-type, stamped-steel terminal with hex head screw.

2.3 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

D. UL KDER - Bonding Bushing:

1. General Characteristics: Threaded bushing with insulated throat.

E. UL KDER - Grounding Bushing:

1. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.4 GROUNDING AND BONDING HUBS

A. Description: Hubs with certified grounding or bonding locknut.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

D. UL KDER - Grounding and Bonding Hub:

1. General Characteristics: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

2.5 GROUNDING AND BONDING CONNECTORS

A. Source Limitations: Obtain products from single manufacturer.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

C. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector:

1. General Characteristics: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.

D. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal:

1. General Characteristics: Mechanical-type, aluminum terminal with set screw.

E. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal:

1. General Characteristics: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on 5/8 or 1 inch (16 or 25 mm) centers for two-bolt connection to busbar.

F. UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal:

1. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.

G. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector:

1. General Characteristics: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.

a. Copper, C and H shaped.

H. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector:

1. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened.

a. Copper.

I. UL KDER - Signal Reference Grid Grounding and Bonding Connector:

1. General Characteristics: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

2.6 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

C. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector:
   1. General Characteristics: Zinc-alloy one-piece construction; six terminating points; gangable.

D. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector:

   1. General Characteristics: Zinc-alloy body and polycarbonate cover; four terminating points.

2.7 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

   1. Regulatory Requirements:

      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

   2. Listing Criteria:

      a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

D. UL KDER - Equipment Room Grounding and Bonding Busbar:

   1. General Characteristics:

      a. Bus: Rectangular bar of annealed copper.
      b. Mounting Stand-Off Insulators: Lexan or PVC.

         1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

   2. Options:

      a. Dimensions: 1/4 by 4 inch (6.3 by 100 mm) in cross section; length as indicated on Drawings.
      b. Predrilled Hole Pattern: Suitable for installing specified grounding and bonding connectors.
      c. Mounting Hardware: Stand-off brackets that provide 2 inch (50 mm) clearance to access rear of bus. Brackets and bolts must be stainless steel.

E. UL KDER - Rack and Cabinet Bonding Busbar:

1. General Characteristics:

    a. Bus: Rectangular bar of hard-drawn solid copper.
    b. Horizontal Mounting Dimensions: Designed for mounting in 19 inch (483 mm) wide equipment racks or cabinets.
    c. Vertical Mounting Dimensions: Designed for mounting in 36 inch (914 mm) high equipment racks or cabinets.
    d. Predrilled Hole Pattern: Accepts connectors for grounding and bonding conductor sizes 14 AWG to 2/0 AWG.
    e. Mounting Hardware: Stainless steel or copper-plated, for attachment to rack.

2.8 SIGNAL REFERENCE GRIDS

A. Description: Means for providing low-impedance path to ground over a large area, approximating an equipotential plan, while simultaneously mitigating large current spikes from faults or lightning.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

D. UL KDER - Mesh-Type Signal Reference Grid:

1. General Characteristics: Conductive metal wire mesh for field-fabrication of grid.

    a. Wire Size: 8 AWG.
    b. Wire Material: Copper.
    c. Spacing: 4 inch (102 mm).
    d. Welded or brazed intersections.

E. UL KDER - Tape-Type Signal Reference Grid:

1. General Characteristics: Conductive copper tape for field-fabrication of grid.

    a. Copper Tape Dimensions: 16 mil (0.4 mm) (26 ga.) thick by 2 inch (51 mm) wide.
    b. Spacing: 24 inch (610 mm).
    c. Welded or brazed fittings for intersections.

2.9 GROUNDING (EARTHING) ELECTRODES

A. Source Limitations: Obtain products from single manufacturer.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Rod Electrode:

1. General Characteristics: Copper-clad steel; 3/4 inch by 10 ft (19 mm by 3 m).

2.10 GROUNDING ELECTRODE ENCLOSURES

A. Description: Enclosures designed to protect grounding electrodes from damage while providing access for inspection and testing of the grounding system.

B. Grounding Electrode Access Well Enclosure:

1. Source Limitations: Obtain products from single manufacturer.
2. Product Characteristics:

a. Well Material: Concrete.
b. Cover Material: Cast iron.
c. Cover Strength: Sidewalk use.

3. Required Product Options:

a. Round:

1) Nominal Diameter: 8 inch (200 mm).
2) Nominal Height: 10 inch (250 mm).
3) Slotted sides for installation after grounding connections made.

b. Rectangular:

1) Nominal Width: 2 inch (50 mm).
2) Nominal Length: 10 inch (250 mm).
3) Nominal Height: 12 inch (300 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

A. Grounding and Bonding Conductors:

1. Provide solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch (6 mm) in diameter.
4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Underground Grounding Conductors: Install bare tinned-copper conductor, 2/0 AWG minimum.

B. Grounding and Bonding Connectors:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on Drawings.

D. Substation Signal Reference Grid:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with IEEE C2.

    a. Install 8 AWG bonding conductors below grade in a grid pattern on 2 ft (600 mm) centers. Bond grid conductors with exothermic welds where they cross each other.
    b. Grid must fill entire area inside equipment yard fence, and extend minimum 6.5 ft (2 m) outside fence, so someone walking or running outside yard may not touch fence or open gate without first stepping inside grid.
    c. Bond each metal fence post and gate post to at least two grid conductors.
    d. Inside grid, bond equipment reinforcing steel inside bases and sidewalks to at least two grid conductors.
    e. Bond underground metal pipe and conduit passing under grid to nearest grid conductor at both ends.

E. Signal Reference Grid Tape Mesh:

1. Install tape mesh under floor finish with the following features:

    a. Tape mesh, 2 inch (50 mm) by 16 mil (0.4 mm) solid copper, 12 inch (300 mm) spacing.

3.3 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Comply with Section 27 05 28 "Pathways for Communications Systems" and Section 27 11 00 "Communications Equipment Room Fittings."

3.4 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:

a. 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. Underground Grounding Conductors:

1) Bury at least 30 inch (750 mm) below grade.
2) Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.

2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. 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 adjacent parts.
2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.

g. 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 bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where 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 bolted connector.
3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft (18 m) apart.

3. Grounding and Bonding Busbars:

a. Install busbar horizontally, on insulated spacers 2 inch (50 mm) minimum from wall, 6 inch (150 mm) above finished floor unless otherwise indicated.
b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

4. Electrodes:

a. Ground Rods: Drive rods until tops are 2 inch (50 mm) 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) Use exothermic welds for below-grade connections.

b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch (300 mm) deep, with cover.

1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

d. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around perimeter of building.

1) Install tinned-copper conductor not less than 2/0 AWG for ring electrode and for taps to building steel.
2) Bury ring electrode not less than 24 inch (600 mm) from building's foundation.

e. Concrete-Encased Electrode (Ufer Ground):

1) Fabricate in accordance with NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 ft (6.0 m) long. If reinforcing is in multiple pieces, connect together by usual steel tie wires or exothermic welding to create required length.

5. Grounding at Service:

   a. Equipment grounding conductors and grounding electrode conductors must be connected to ground busbar. Install main bonding jumper between neutral and ground buses.

6. Grounding Separately Derived Systems:

   a. Permanent Generators: Install grounding electrode(s) at location of permanent generators having switched neutral connections. Electrode must be connected to equipment grounding conductor and to frame of generator.

7. Grounding Underground Distribution System Components:

   a. Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.
   b. Comply with IEEE C2 grounding requirements.
   c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch (50 mm) above to 6 inch (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
   d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
   e. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than 6 inch (150 mm) from foundation.

8. Equipment Grounding and Bonding:

a. Install insulated equipment grounding conductors with feeders and branch circuits.
b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

    1) Feeders and branch circuits.
    2) Lighting circuits.
    3) Receptacle circuits.
    4) Single-phase motor and appliance branch circuits.
    5) Three-phase motor and appliance branch circuits.

c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
e. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

3.5 INSTALLATION OF GROUNDING AND BONDING FOR TOWERS AND ANTENNAS

A. Special Techniques:

1. Ring Electrode: Buried at least 30 inch (760 mm) below grade and at least 24 inch (610 mm) from base of tower or mounting.
2. Bond each tower base and metallic frame of dish to ring electrode, buried at least 18 inch (460 mm) below grade.
3. Bond ring electrode and antenna bonding conductors to equipment room PBB or SBB, buried at least 30 inch (760 mm) below grade.
4. Bond metal fences located within 6 ft (1.8 m) of towers and antennas to ring electrode, buried at least 18 inch (460 mm) below grade.

3.6 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by 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 in accordance with IEEE Std 81.
    c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

C. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:

    a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω.
    b. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 Ω.
    c. Substations and Pad-Mounted Equipment: 5 Ω.
    d. Manhole Grounds: 10 Ω.

3.7 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Support, anchorage, and attachment components.
2. Fabricated metal equipment support assemblies.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

    a. Slotted support systems, hardware, and accessories.
    b. Clamps.
    c. Hangers.
    d. Sockets.
    e. Eye nuts.
    f. Fasteners.
    g. Anchors.
    h. Saddles.
    i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

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 (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel or Stainless steel, Type 304.
3. Channel Width: Selected for applicable load criteria .
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel and Stainless steel hangers, clamps, 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 electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

D. 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 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 F3125/F3125M, Grade A325 (Grade A325M).
6. Toggle Bolts: **All** steel springhead type.
7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA NEIS 101

B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch (6 mm) in diameter.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch (38 mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT and IMC may be supported by openings through structure members, in accordance with NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch (100 mm) thick.
5. To Light Steel: Sheet metal screws.
6. 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.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inch (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Anchor equipment to concrete base as follows:

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.

3.5 PAINTING

A. Touchup:

1. 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.

    a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

SECTION 26 05 33.13

CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Type EMT duct raceways and elbows.
2. Type ERMC duct raceways, elbows, couplings, and nipples.
3. Type FMC duct raceways.
4. Type IMC duct raceways.
5. Type LFMC duct raceways.
6. Type PVC duct raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Joint compounds.
9. Solvent cements.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 26 05 53 "Identification for Electrical Systems" for electrical equipment labels.

C. Related Requirements:

1. Section 26 05 19 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
2. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. Conduit: A structure containing one or more duct raceways.

B. Duct Raceway: A single enclosed raceway for conductors or cable.

C. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:

PART 2 - PRODUCTS

2.1 TYPE EMT-A AND TYPE EMT-SS DUCT RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 TYPE EMT DUCT RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FJMX; including UL 797.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Material: Steel.
2. Options:

a. Exterior Coating: **Zinc**.

b. Interior Coating: Zinc with organic top coating.
c. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
d. Colors: As indicated on Drawings.

2.3 TYPE ERMC DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DYIX; including UL 6.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:

1. Exterior Coating: Zinc.
2. Options:

a. Interior Coating: Zinc with organic top coating.
b. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
c. Colors: As indicated on Drawings.

D. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:

1. Options:

a. Exterior Coating: PVC complying with NEMA RN 1.
b. Interior Coating: Zinc with organic top coating.
c. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
d. Colors: As indicated on Drawings.

2.4 TYPE FMC-S AND TYPE FMC-A DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DXUZ; including UL 1.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):

1. Material: Steel.
2. Options:

a. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
b. Colors: As indicated on Drawings.

D. UL DXUZ - Aluminum Flexible Metal Conduit (FMC-A):

1. Options:

a. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
b. Colors: As indicated on Drawings.

2.5 TYPE FMT DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ILJW; including UL Subject 1652.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL ILJW - Steel Flexible Metallic Tubing (FMT):

1. Options:

a. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
b. Colors: As indicated on Drawings.

2.6 TYPE IMC DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DYBY; including UL 1242.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DYBY - Steel Intermediate Metal Conduit (IMC):

1. Options:

a. Exterior Coating: Zinc.
b. Interior Coating: Zinc with organic top coating.
c. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
d. Colors: As indicated on Drawings.

2.7 TYPE LFMC DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DXHR; including UL 360.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Material: Steel.
2. Options:

    a. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
    b. Colors: As indicated on Drawings.

2.8 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DZYR; including UL 651.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Dimensional Specifications: Schedule 40.
2. Options:

    a. Minimum Trade Size: 3/4" for 120VAC and above, 1”C for all data and security uses.
    b. Markings: For use with maximum 90 deg C wire.

2.9 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DWTT - Fittings for Type ERMC, Type IMC, Type PVC, Type HDPE, Type EPEC, and Type RTRC Duct Raceways:

1. Listing Criteria: UL CCN DWTT; including UL 514B.
2. Options:

a. Material: Steel.
b. Coupling Method: Compression coupling.
c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

D. UL FKAV - Fittings for Type EMT Duct Raceways:

1. For assistance with finding guide information for UL Category Control Numbers and identifying UL-approved manufacturers, consult the UL Product iQ database at https://iq.ulprospector.com/.
2. Listing Criteria: UL CCN FKAV; including UL 514B.
3. Options:

a. Material: Steel.
b. Coupling Method: Compression coupling.
c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

E. UL ILNR - Fittings for Type FMC Duct Raceways:

1. Listing Criteria: UL CCN ILNR; including UL 514B.

F. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:

1. Listing Criteria: UL CCN DXAS; including UL 514B.

2.10 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FOIZ; including UL Subject 2419.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

2.11 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DWTT; including UL 514B.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Sustainable Design Submittals: Prepare and submit the following documentation:
3. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DWTT - Solvent Cements for Type PVC Duct Raceways and Fittings:

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Outdoors:

1. Exposed and Subject to Severe Physical Damage: ERMC.
2. Exposed and Subject to Physical Damage: ERMC

    a. Locations less than 2.5 m (8 ft) above finished floor.

3. Exposed and Not Subject to Physical Damage: ERMC or IMC.
4. Concealed Aboveground: ERMC or IMC.
5. Direct Buried: PVC-40.
6. Concrete Encased Not in Trench: PVC-40.
7. Concrete Encased in Trench: PVC-40.
8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

C. Indoors:

1. Exposed and Subject to Severe Physical Damage: ERMC. Locations include the following:

    a. Loading docks.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.

2. Exposed and Subject to Physical Damage: ERMC or IMC. Locations include the following:

a. Locations less than 2.5 m (8 ft) above finished floor.
b. Stub-ups to above suspended ceilings.

3. Exposed and Not Subject to Physical Damage: ERMC or IMC.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: ERMC or IMC.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC or FMC.

D. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Type EMT-A: Article 358 of NFPA 70 and NECA NEIS 102.
2. Type EMT-SS: Article 358 of NFPA 70 and NECA NEIS 101.
3. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
4. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
5. Type HDPE and Type EPEC: Article 353 of NFPA 70 and NECA NEIS 111.
6. Type ERMC-A: Article 344 of NFPA 70 and NECA NEIS 102.
7. Type ERMC-SS: Article 344 of NFPA 70 and NECA NEIS 101.
8. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
9. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
10. Type FMC-A: Article 348 of NFPA 70 and NECA NEIS 102.
11. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
12. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.
13. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
14. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
15. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
16. Type RTRC: Article 355 of NFPA 70 and NECA NEIS 111.
17. Expansion Fittings: NEMA FB 2.40.
18. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

    a. Complete duct raceway installation before starting conductor installation.
    b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft (0.6 m) above finished floor.
    c. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch (300 mm) of changes in direction.
    d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
    e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
    f. Support conduit within 12 inch (300 mm) of enclosures to which attached.
    g. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:

        1) Where an underground service duct raceway enters a building or structure.
        2) Conduit extending from interior to exterior of building.
        3) Where otherwise required by NFPA 70.

    h. Do not install conduits within 2 inch (50 mm) of the bottom side of a metal deck roof.
    i. Keep duct raceways at least 6 inch (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
    j. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
    k. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb (90 kg) tensile strength. Leave at least 12 inch (300 mm) of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
    l. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

        1) Termination fittings with shoulders do not require two locknuts.

    m. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on

metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts.

2. Types ERMC and IMC:

   a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

3. Type ERMC-S-PVC:

   a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
   b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-S-PVC duct raceway.
   c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

4. Types FMC, LFMC:

   a. Provide a maximum of 36 inch (915 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

5. Types PVC:

   a. Do not install Type PVC conduit where ambient temperature exceeds 122 deg F (50 deg C). Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
   b. Comply with manufacturer's published instructions for solvent welding and fittings.

6. Duct Raceways Embedded in Slabs:

   a. Arrange duct raceways to cross building expansion joints with expansion fittings at right angles to the joint.
   b. Arrange duct raceways to ensure that each is surrounded by minimum of 1 inch (25 mm) of concrete without voids.
   c. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.
   d. Change from ENT to ERMC or IMC before rising above floor.

7. Stub-ups to Above Recessed Ceilings:

   a. Provide EMT, IMC, or ERMC for duct raceways.

b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

8. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. Install insulated throat metal grounding bushings on service conduits.

9. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

a. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
b. EMT: Provide compression, steel fittings. Comply with NEMA FB 2.10.
c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

10. Expansion-Joint Fittings:

a. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

b. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
c. Install expansion fittings at locations where conduits cross building or structure expansion joints.
d. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

11. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

12. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

    a. Provide warning signs.

D. Interfaces with Other Work:

1. Coordinate with Section 07 84 13 "Penetration Firestopping" for installation of firestopping at penetrations of fire-rated floor and wall assemblies.
2. Coordinate with Section 26 05 29 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 33.16

BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

PART 2 - PRODUCTS

2.1 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QCIT; including UL 514A.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL QCIT - Metallic Outlet Boxes and Covers:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
2. Options:

a. Material: Sheet steel.
b. Sheet Metal Depth: Minimum 2 inch (50 mm).
c. Cast-Metal Depth: Minimum 2.4 inch (60.3 mm).
d. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing more than 50 lb (23 kg) and marked with maximum allowable weight.
e. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb (32 kg).

D. UL QCIT - Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

E. UL QCIT - Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.
2. Options:

a. Material: Sheet steel.
b. Sheet Metal Depth: minimum 2.0 inch (50 mm).
c. Cast-Metal Depth: minimum 2.4 inch (60.3 mm).

F. UL QCIT - Metallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

G. UL QCIT - Metallic Concrete Boxes and Covers:

1. Description: Box intended for use in poured concrete.

2.2 JUNCTION BOXES AND PULL BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN BGUZ; including UL 50 and UL 50E.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Options:

a. Degree of Protection: Type 1.

D. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Options:

a. Degree of Protection: Type 3R.

E. UL BGUZ - Outdoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Options:

a. Degree of Protection: Type 3R.

2.3 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN QCIT or UL CCN QCMZ; including UL 514D.
3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:

1. Options:

a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
b. Wallplate Material: 0.032 inch (0.8 mm) thick, Type 302/304 non-magnetic stainless steel with brushed finish.

2.4 HOODS FOR OUTLET BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria:

a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

3. Mounts to box using fasteners different from wiring device.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:
1. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.

2. Options:

    a. Provides gray, weatherproof, "while-in-use" cover.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

    a. Type 3R unless otherwise indicated.
    b. Locations Exposed to Hosedown: Type 4.
    c. Locations Subject to Potential Flooding: Type 6P.

2. Indoors:

    a. Type 1 unless otherwise indicated.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:

1. Boxes with knockouts or unprotected openings are prohibited.
2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. 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 bottom of box unless otherwise indicated.

3. 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, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
10. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.

11. Identification: Provide labels for boxes and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Provide warning signs.
    c. Label each box with engraved metal or laminated-plastic nameplate.

3.3 CLEANING

A. Remove construction dust and debris from boxes before installing wallplates, covers, and hoods.

3.4 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Type PVC raceways and fittings.
2. Fittings for conduit, tubing, and cable.
3. Electrically conductive corrosion-resistant compounds for threaded conduit.
4. Solvent cements.
5. Duct accessories.
6. Handholes and boxes for exterior underground wiring.
7. Duct sealing.

B. Related Requirements:

1. Section 26 05 19 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
2. Section 26 05 53 "Identification for Electrical Systems" specifies underground-line warning tape and concrete cable routing markers (warning planks).

1.3 DEFINITIONS

A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.

B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.

C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.

D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For concrete and steel used in precast concrete handholes, also include product certificates as required by ASTM C858.

B. Shop Drawings:

1. Precast or Factory-Fabricated Concrete Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include cover design.

C. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

B. Field Reports:

1. Factory Test Reports: For handholes and boxes.

PART 2 - PRODUCTS

2.1 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Dimensional Specifications: Schedule 40.
2. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
b. Markings: For use with maximum 90 deg C wire.

C. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

1. Dimensional Specifications: Type A.
2. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.2 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.

2.3 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

2.4 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

B. Precast Concrete Handholes and Boxes:

1. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover must form top of enclosure and must have load rating consistent with that of handhole or box.
2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
3. Frame and Cover:

    a. Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
    b. Weatherproof steel frame, with concealed-hinge steel access door assembly; tamper-resistant, captive, cover-securing bolts; hold-open ratchet assembly; and recessed cover handle.
    c. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
    d. Cover Legend: Molded lettering, "ELECTRIC" .

4. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

    a. Extension must provide increased depth of 12 inch (300 mm).
    b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

5. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.

6. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

    a. Type and size: Match fittings to duct to be terminated.
    b. Fittings must align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
    c. Provide minimum of one cast end-bell or duct-terminating fitting of each size provided in each wall.

7. Handholes 24 inch wide by 48 inch long (600 mm wide by 1200 mm long) and larger must have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover:

1. Description: Molded of sand, concrete, and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or combination.
2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and installed location.

a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
b. Cover Legend: Molded lettering, "ELECTRIC".

4. Conduit Entrance Provisions: Conduit-terminating fittings must mate with entering ducts for secure, fixed installation in enclosure wall.
5. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
6. Handholes 24 inch wide by 48 inch long (600 mm wide by 1200 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
7. Options:

a. Color: Gray.

D. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover:

1. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
b. Cover Legend: Molded lettering, "ELECTRIC”.

4. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
5. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
6. Options:

a. Color: Gray.

E. Fiberglass Handholes and Boxes:

1. Description: Molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete.
2. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
b. Cover Legend: Molded lettering, "ELECTRIC".

4. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
5. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
6. Handholes 24 inch wide by 48 inch long (600 mm wide by 1200 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
7. Options:

    a. Color: Gray.

2.5 DUCT SEALING

A. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Compound must be capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests for Handholes and Boxes:

1. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

    a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
    b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

2. Nonconforming Work:

    a. Equipment that does not pass tests and inspections will be considered defective.

3. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct 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 and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain in accordance with Section 31 10 00 "Site Clearing." Remove and stockpile topsoil for reapplication in accordance with Section 31 10 00 "Site Clearing."

3.2 SELECTION OF UNDERGROUND DUCTS

A. Duct for Electrical Cables More Than 600 V: PVC-40, concrete encased unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less: PVC-40, concrete encased unless otherwise indicated.

C. Duct for Electrical Branch Circuits: PVC-40, direct buried unless otherwise indicated.

D. Underground Ducts Crossing Paved Paths Walks and Driveways: PVC-40, encased in reinforced concrete.

E. Underground Ducts Crossing Roadways and Railroads: PVC-40, encased in reinforced concrete.

F. Stub-ups: Concrete encased, PVC-40.

3.3 SELECTION OF UNDERGROUND ENCLOSURES

A. Handholes and Boxes:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested in accordance with SCTE 77 with 3000 lbf (13 345 N) vertical loading.
5. Cover design load must not exceed load rating of handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Restore area after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 92 00 "Turf and Grasses" and Section 32 93 00 "Plants."

E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 01 73 00 "Execution."

3.5 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Slope: Pitch duct minimum slope of 1:300 down toward handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
3. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to handhole.

4. Install expansion fitting near center of straight line duct with calculated expansion of more than 3/4 inch (19 mm).
5. Curves and Bends:

    a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inch (1200 mm) both horizontally and vertically, at other locations unless otherwise indicated.
    b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of 48 inch (1200 mm). Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
    c. Duct must have maximum of 180 degrees of bends between pull points.

6. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.
7. End Bell Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inch (250 mm) o.c. for 5 inch (125 mm) duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to end-bell spacing 10 ft (3 m) from end bell, without reducing duct slope and without forming trap in line.
    b. Grout end bells into structure walls from both sides to provide watertight entrances.

8. Duct Terminators for Entrances to Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inch (150 mm) o.c. for 4 inch (100 mm) duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to terminator spacing 10 ft (3 m) from terminator, without reducing duct line slope and without forming trap in line.
9. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

    a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.

10. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig (1.03 MPa) hydrostatic pressure.
11. Pulling Cord: Install 200 lbf (1000 N) test nylon cord in empty ducts.
12. Concrete-Encased Ducts and Duct Bank:

a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes 6 inch (150 mm) or less in nominal diameter.
b. Width: Excavate trench 3 inch (75 mm) wider than duct on each side.
c. Depth: Install so top of duct envelope is at least 24 inch (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inch (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. 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.
f. Minimum Space between Ducts: 3 inch (75 mm) between edge of duct and exterior envelope wall, 2 inch (50 mm) between ducts for like services, and 4 inch (100 mm) between power and communications ducts.
g. Elbows:

    1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.

h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of equipment base.

    1) Stub-ups must be minimum 4 inch (100 mm) above finished floor and minimum 3 inch (75 mm) from conduit side to edge of slab.

i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.

    1) Stub-ups must be minimum 4 inch (100 mm) above finished floor and no less than 3 inch (75 mm) from conduit side to edge of slab.

j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
k. 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.
l. Concrete Cover: Install minimum of 3 inch (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inch (50 mm) between duct of like services, and 4 inch (100 mm) between power and communications ducts.

m. Place minimum 6 inch (150 mm) of engineered fill above concrete encasement of duct.
n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
2) If more than one pour is necessary, terminate each pour in vertical plane and install 3/4 inch (15 mm) reinforcing-rod dowels extending minimum of 18 inch (450 mm) into concrete on both sides of joint near corners of envelope.

o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

13. Direct-Buried Duct and Duct Bank:

a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 31 20 00 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inch (150 mm) in nominal diameter.
b. Width: Excavate trench 3 inch (75 mm) wider than duct on each side.
c. Depth: Install top of duct at least 36 inch (900 mm) below finished grade unless otherwise indicated.
d. Set elevation of top of duct bank below frost line.
e. Place minimum 3 inch (75 mm) of sand as bed for duct. Place sand to minimum of 6 inch (150 mm) above top level of duct.
f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. 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.
h. Install duct with minimum of 3 inch (75 mm) between ducts for like services and 6 inch (150 mm) between power and communications duct.
i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

j. After installing first tier of duct, 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 inch (100 mm) over duct 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 31 20 00 "Earth Moving" for installation of backfill materials.

14. Underground-Line Warning Tape: Bury conducting underground line specified in Section 26 05 53 "Identification for Electrical Systems" no less than 12 inch (300 mm) above concrete-encased duct and duct banks and approximately 12 inch (300 mm) below grade. Align tape parallel to and within 3 inch (75 mm) of centerline of duct bank. Provide additional warning tape for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional tapes 12 inch (300 mm) apart, horizontally across width of ducts.
15. Ground ducts and duct banks in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.6 INSTALLATION OF CONCRETE HANDHOLES AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Precast Concrete Handholes:

a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from 1 inch (25 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.
c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

2. Elevations:

a. Install handholes with bottom below frost line.
b. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

c. Where indicated, cast handhole cover frame integrally with handhole structure.

3. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
4. Manhole Access: Circular opening in manhole roof; sized to match cover size.

a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
b. Install chimney, constructed of precast concrete collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch (12.5 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Install handholes and boxes with bottom below frost line.
5. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
6. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on compacted earth.

a. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with troweled finish.
b. Dimensions: 10 inch wide by 12 inch deep (250 mm wide by 300 mm deep).

3.8 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by authorities having jurisdiction .

B. Tests and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, 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 minimum 12 inch (300 mm) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.

C. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.9 CLEANING

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

B. Clean internal surfaces of manholes, including sump, and building interiors affected by Work.

1. Remove foreign material.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Labels.
2. Extruded insulating tubing.
3. Bands.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

B. UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

2.2 EXTRUDED INSULATING TUBING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

B. UL YDPU2 - Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F (93 deg C).

2.3 BANDS

A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.

2.4 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil (0.08 mm) thick by 1 to 2 inch (25 to 50 mm) wide; compounded for outdoor use.

C. Tape and Stencil: 4 inch (100 mm) wide black stripes on 10 inch (250 mm) centers placed diagonally over orange background and are 12 inch (300 mm) wide. Stop stripes at legends.

D. Floor Marking Tape: 2 inch (50 mm) wide, 5 mil (0.125 mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:

a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical utility lines.
b. Printing on tape must be permanent and may not be damaged by burial operations.
c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

    a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
    b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW".

3. Detectable Line-Warning Tape :

    a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
    b. Width: 3 inch (75 mm).
    c. Overall Thickness: 5 mil (0.125 mm).
    d. Foil Core Thickness: 0.35 mil (8.9 m).
    e. Weight: 28 lb/1000 sq. ft (13.7 kg/100 sq. m).
    f. Tensile in accordance with ASTM D882: 70 lbf (311.3 N) and 4600 psi (31.7 MPa).

2.5 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch (0.38 mm) thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

C. Write-on Tags:

1. Polyester Tags: 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags:

    a. Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.6 SIGNS

A. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:

    a. For signs up to 20 sq. inch (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
    b. For signs larger than 20 sq. inch (129 sq. cm), 1/8 inch (3.2 mm) thick.

c. Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting.
d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.

B. UL ZODZ - General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

C. UL ZODZ - UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.

2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft (2.3 m) above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1 and IEEE C2.

C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

1. Color must be factory applied or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction.
2. Colors for 208Y/120 V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 480Y/277 V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

4. Color for Neutral (Grounded Conductor): White or gray.
5. Color for Equipment Ground: Bare copper or Green with yellow stripe.
6. Color for Isolated Ground: Green with two or more yellow stripes.

D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.

E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

F. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "POWER."
2. "UPS."

G. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

H. Locations of Underground Lines: Underground-line warning tape for power and lighting.

I. Vaults, Manholes, Handholes, and Pull and Junction Boxes, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation.

J. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3 inch (75 mm) high, black letters on 20 inch (500 mm) centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10 ft (3 m) maximum intervals.
2. Identify system voltage with black letters on orange field.
3. Apply floor marking tape to the following finished surfaces:

    a. Floor surface directly above conduits running beneath and within 12 inch (300 mm) of floor that is in contact with earth or is framed above unexcavated space.
    b. Wall surfaces directly external to raceways concealed within wall.
    c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Accessible Raceways, More Than 1000 V: Vinyl wraparound labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
2. Identify system voltage with black letters on orange field.

L. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
2. Identify system voltage with black letters on orange field.

M. Accessible Raceway, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
2. Identify system voltage with black letters on orange field.

N. Conductors to Be Extended in Future: Attach marker tape to conductors and list source.

O. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:

1. Panelboard designation.
2. Colon or dash.
3. Branch circuit number.

P. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

Q. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: Self-adhesive label.
3. Outdoor Equipment: Laminated acrylic or melamine sign.
4. Equipment to Be Labeled:

Identification labeling of some items listed below may be required by individual Sections or by NFPA 70.

a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
c. Enclosures and electrical cabinets.
d. Access doors and panels for concealed electrical items.
e. Switchgear.
f. Switchboards.
g. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
h. Substations.
i. Emergency system boxes and enclosures.
j. Motor-control centers.
k. Enclosed switches.
l. Enclosed circuit breakers.
m. Enclosed controllers.
n. Variable-speed controllers.
o. Push-button stations.
p. Power-transfer equipment.
q. Contactors.
r. Remote-controlled switches, dimmer modules, and control devices.
s. Uninterruptible power supplies.
t. Battery-inverter units.
u. Battery racks.
v. Power-generating units.
w. Monitoring and control equipment.

R. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with NFPA 70E requirements for arc-flash hazard warning labels.
2. Raceways and Cables Carrying Circuits at More Than 1000 V:

    a. Black letters on orange field.
    b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

    a. Power-transfer switches.
    b. Controls with external control power connections.

E. Operating Instruction Signs: Self-adhesive labels.

3.4 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

A. Comply with Section 27 05 28 "Pathways for Communications Systems" and Section 27 11 00 "Communications Equipment Room Fittings."

3.5 INSTALLATION

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 260011 "Facility Performance Requirements for Electrical."

C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

F. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Verify identity of item before installing identification products.

H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

I. Apply identification devices to surfaces that require finish after completing finish work.

J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

U. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape not less than 12 inch (300 mm) directly above cables or raceways buried 18 inch (450 mm) or more below grade. Use multiple tapes where width of multiple lines installed in common trench exceeds 16 inch (400 mm) overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

V. Metal Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

W. Nonmetallic Preprinted Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

X. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

Y. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

Z. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

AA. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Outdoor photoelectric switches, solid state, luminaire-mounted.
2. Indoor occupancy.
3. Switchbox-mounted occupancy sensors.
4. High-bay occupancy sensors.
5. Lighting contactors.
6. Emergency shunt relay.
7. Conductors and cables.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Outdoor photoelectric switches, solid state, luminaire-mounted.
2. Indoor occupancy.
3. Switchbox-mounted occupancy sensors.
4. High-bay occupancy sensors.
5. Lighting contactors.
6. Emergency shunt relay.
7. Conductors and cables.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.5 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, LUMINAIRE-MOUNTED

A. Description: Solid state, with dry contacts rated for 1800 VA inductive, to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Lightning Arrester: Air-gap type.
5. Mounting: Twist lock complying with ANSI C136.10, with base from same source and manufacturer as switch.
6. Failure Mode: Luminaire stays ON.

2.2 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Wall-mounted and Ceiling-mounted, solid-state indoor occupancy sensors.
2. Dual technology.
3. Separate power pack.

4. Hardwired connection to switch and BAS.
5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
6. Operation:

    a. Occupancy Sensor: 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.

7. Sensor Output: Sensor is powered from the power pack.
8. Power: Line voltage.
9. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
10. Mounting:

    a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
    b. Relay: Externally mounted through a 1/2 inch (13 mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); turn lights off when selected lighting level is present.

B. Dual-Technology Type: Wall and Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm), and detect a person of average size and weight moving not less than 12 inch (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inch/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96 inch (2440 mm) high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 2000 sq. ft. (220 sq. m) when mounted 48 inch (1200 mm) above finished floor.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired connection.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
4. Switch Rating: Not less than 800 VA LED load at 120 V, 1200 VA LED load at 277 V, and 800 W incandescent.

B. Wall-Switch Sensor Tag OS:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Match the circuit voltage.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lx). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
9. Color: White.
10. Faceplate: Color matched to switch.

2.4 HIGH-BAY OCCUPANCY SENSORS

A. Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
4. Power: Line voltage.

5. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
6. Mounting: Threaded pipe.
7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
8. Detector Technology: PIR.
9. Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor.

B. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 ft. (3.7 to 15.2 m).

C. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.5 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 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "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 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

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

3.2 INSTALLATION OF SENSORS

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 instructions.

3.3 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.

C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 26 05 53 "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.

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Tenant.

B. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software support for two years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.

    a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION

SECTION 26 12 19

PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pad-mounted, liquid-filled, medium-voltage distribution transformers, with primary and secondary bushings within or without air-terminal enclosures.

1.2 DEFINITIONS

A. BIL: Basic Impulse Insulation Level.

B. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

C. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."

D. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or nonload break, separable insulated connector (bushing).

E. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

F. Elbow Connector: See "bushing elbow" above.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For pad-mounted, liquid-filled, medium-voltage transformers.

1. Include plans and elevations showing major components and features.

a. Include a plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.

2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include single-line diagram.
4. Include list of materials.
5. Include nameplate data.
6. Manufacturer's published time-current curves of the transformer high-voltage fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For transformers, signed by product manufacturer.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformer and accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 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 IEEE C2.

C. Comply with IEEE C57.12.00.

2.2 PERFORMANCE REQUIREMENTS

A. Windings Material: Copper.

B. Insulating Liquids:

1. Less-Flammable Liquids:

a. Edible-Seed-Oil-Based Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic, having passed the Organization for Economic Co-operation and Development G.L.203 with zero mortality, and shall be certified by the

U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.

C. Corrosion Protection:

1. Transformer coating system shall be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

2. Base and Cabinets of Two Compartment Transformers: Fabricate from stainless steel according to ASTM A 167, Type 304 or 304L, not less than No. 13 U.S. gage. Coat transformer with manufacturer's standard green color coating complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

2.3 THREE-PHASE TRANSFORMERS

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

1. ABB.
2. Cooper Industries; Cooper Power Systems Division.
3. Eaton Corporation; Electrical Sector.
4. General Electric Company; Electrical Distribution & Control Products.
5. Square D, a division of Schneider Electric.
6. Siemens Industry.

B. Description:

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with IEEE C57.12.26.

C. Compartment Construction:

1. Double-Compartment Construction: Individual compartments for high- and low-voltage sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with a stop in the open position and provision for padlocking.

D. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.

1. 150-kV BIL current-limiting fuses, conforming to requirements of IEEE C37.47.
2. Interrupting Rating: 50,000 rms A symmetrical at system voltage.
3. Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse shall sense both high currents and high oil temperature to provide thermal protection to the transformer.
4. Provide bayonet fuse assembly with an oil retention valve and an external drip shield inside the housing to eliminate or minimize oil spills. Valve shall close

when fuse holder is removed and an external drip shield is installed.

5. Provide a conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

E. High-Voltage Section: Dead-front design.

1. To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 26 05 13 "Medium-Voltage Cables." Bushings shall be one-piece units, with ampere and BIL ratings the same as connectors.

2. Bushing inserts and feed-through inserts:

   a. Conform to the requirements of IEEE 386.
   b. Rated at 200 A, with voltage class matching connectors. Provide a parking stand near each bushing well. Parking stands shall be equipped with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.
   c. Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts and insulated standoff bushings.

3. Bushing wells configured for loop-feed application.

4. Access to liquid-immersed fuses.

5. Dead-front surge arresters.

   a. Distribution class; metal-oxide-varistor type, fully shielded, separable elbow type, suitable for plugging into the inserts. Comply with IEEE C62.11 and IEEE 386.

6. Primary Tap Changer with external operating control within the tamperproof enclosure; clearly labeled "DO NOT OPERATE WHEN TRANSFORMER IS ENERGIZED". Transformers shall be provided with full capacity taps in accordance with Table 2 of IEEE Standard C57.I2.22.

7. Load-Break Switch:

   a. Loop-feed sectionalizing switches, using three two-position, liquid-immersed-type switches for closed transition loop-feed and sectionalizing operation. Voltage class and BIL shall match that of separable connectors, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 12 kA rms symmetrical. Switch operation shall be as follows:

      1) Position I: Line A connected to line B and both lines connected to the transformer.
      2) Position II: Transformer connected to line A only.
      3) Position III: Transformer connected to line B only.

4) Position IV: Transformer disconnected and line A not connected to line B.
5) Position V: Transformer disconnected and line A connected to line B.

F. Low-Voltage Section:

1. Bushings with spade terminals drilled for terminating the number of conductors indicated on the Drawings, and the lugs that comply with requirements of Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

G. Capacities and Characteristics:

1. Taps: (2) 2-1/2% above and below nominal voltage.
2. Transformer BIL (kV): 95 kV.
3. Minimum Tested Impedance (Percent at 85 deg C): 5.75.
4. Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

H. Transformer Accessories:

1. Drain and filter connection with 1/2 inch sampler.
2. Filling and top filter press connections.
3. Pressure-vacuum gauge.
4. Dial-type analog thermometer with alarm contacts.
5. Automatically resetting pressure-relief device. Device flow shall be as recommended by manufacturer.
6. Machine-engraved nameplate, made of anodized aluminum or stainless steel.
7. Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide with seal-in delay.

2.4 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 26 05 53 "Identification for Electrical Systems."

1. High-Voltage Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s). Sign legend shall be "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch-high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background.
2. Arc Flash Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s), warning of potential electrical arc flash hazards and appropriate personal protective equipment required.

2.5 SOURCE QUALITY CONTROL

A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.90.

1. Perform the following factory-certified routine tests on each transformer for this

Project:

a. Resistance.
b. Turns ratio, polarity, and phase relation.
c. Transformer no-load losses and excitation current at 100 percent of ratings.
d. Transformer impedance voltage and load loss.
e. Operation of all devices.
f. Lightning impulse.
g. Low frequency.
h. Leak.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.

1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.
2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on high- or low-voltage bushing parts, and at transformer base.
5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
7. Verify presence of polychlorinated biphenyl content labeling.
8. Unload transformers carefully, observing all packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil

mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.

4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Verify that an effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:

1. Verify removal of any shipping bracing after placement.
2. Remove a sample of insulating liquid according to ASTM D 923. Insulating-liquid values shall comply with NETA ATS, Table 100.4. Sample shall be tested for the following:

a. Dielectric Breakdown Voltage: ASTM D 877 or ASTM D 1816.
b. Acid Neutralization Number: ASTM D 974.
c. Interfacial Tension: ASTM D 971.
d. Color: ASTM D 1500.
e. Visual Condition: ASTM D 1524.
f. Water in Insulating Liquids: Comply with ASTM D 1533.
g. Power Factor or Dissipation Factor: ASTM D 924.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 3 ohms at transformer location.

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

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.

C. Comply with requirements for vibration isolation specified in Section 260529 "Hangers and Supports for Electrical Systems".

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and IEEE C2.

3.3 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
2. Make joints in grounding conductors and loops by exothermic weld or compression connector.
3. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure.
4. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer

recommendations.

2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of transformers according to Section 26 05 13 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 26 05 53 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of NFPA 70B Ch. "Testing and Test Methods."
b. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at the transformer is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

f. Remove and replace malfunctioning units and retest.
g. Prepare test and inspection reports. Record as-left set points of all adjustable devices.

2. Medium-Voltage Surge Arrester Field Tests:

    a. Visual and Mechanical Inspection:

        1) Inspect physical and mechanical condition.
        2) Verify arresters are clean.
        3) Verify that ground lead on each device is individually attached to a ground bus or ground electrode.

    b. Electrical Test:

        1) Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.
        2) Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Liquid-Filled Transformer Field Tests:

    a. Visual and Mechanical Inspection:

        1) Test dew point of tank gases if applicable.
        2) Inspect anchorage, alignment, and grounding.
        3) Verify bushings are clean.
        4) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
        5) Verify that liquid level in tanks is within manufacturer's published tolerances.
        6) Perform specific inspections and mechanical tests recommended by manufacturer.
        7) Verify presence of transformer surge arresters and that their ratings are as specified.
        8) Verify that as-left tap connections are as specified.

    b. Electrical Tests:

        1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.
        2) Perform power-factor or dissipation-factor tests on all windings according to test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.3.

3) Measure core insulation resistance at 500-V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each transformer. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Adjust transformer taps.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Report:

    a. Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove all necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 degree C. at 30 degrees C.
3. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

4. Act on inspection results according to recommendations of NETA ATS, Table

100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION

SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Grounded to enclosure.

C. Coils: Continuous windings **without splices** except for taps.

1. Coil Material: **Copper**.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.

D. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Environmental Protection:

    a. Indoor: UL 50E, Type 2.

5. Finish Color: Gray weather-resistant enamel.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

F. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

G. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

H. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding shield.

I. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

2.4 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."
2. Self-adhesive label for distribution transformers. Self-adhesive labels are specified in Section 26 05 53 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Testing Administrant: Engage qualified electrical testing agency to evaluate transformer.

B. Factory Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance on control units.

1. Resistance measurements of windings at rated voltage connections and at tap connections.
2. Ratio tests at rated voltage connections and at tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

    a. Line-side to ground.
    b. Load-side to ground.
    c. Line-side to load-side.

9. Temperature tests.
10. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

C. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

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

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base in accordance with manufacturer's published instructions.

E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

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

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Tenant.

B. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

D. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Assemble and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.5 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.

1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Power panelboards.
2. Disconnecting and overcurrent protective devices.

1.3 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Power panelboards.
2. Disconnecting and overcurrent protective devices.
3. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
4. 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, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.

5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field Quality-Control Submittals:

1.5 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

B. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Recommended procedures for installing panelboards.
2. Recommended torque settings for bolted connections on panelboards.
3. Recommended temperature range for energizing panelboards.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with NEMA PB 1.

1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: UL 50E, Type 1.
    b. Outdoor Locations: UL 50E, Type 3R .

2. Height: 7 ft (2.13 m) maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
5. Finishes:

    a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Same finish as panels and trim.
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

F. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

    a. Bus must be fully rated for entire length.

2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations must allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.

I. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

J. Future Devices: Panelboards must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 20 percent.

K. Panelboard Short-Circuit Current Rating:

1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.2 PANELBOARDS

A. Listing Criteria: NEMA PB 1, distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inch (914 mm) high, provide two latches, keyed alike.

C. Mains: Circuit breaker or Lugs only.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Door-in-door construction with concealed hinges; secured with flush latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
4. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. UL listed for reverse connection without restrictive line or load ratings.
    d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    e. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on position.
    g. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 A must have interchangeable rating plugs or electronic adjustable trip units.

h. Multipole units enclosed in single housing with single handle or factory assembled to operate as single unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Equipment Mounting:

    a. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Comply with mounting and anchoring requirements by manufacturer.
4. Mount top of trim 7.5 ft (2.3 m) above finished floor unless otherwise indicated.
5. Mount panelboard cabinet plumb and rigid without distortion of box.
6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.

    a. Set field-adjustable, circuit-breaker trip ranges.
    b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
9. Install filler plates in unused spaces.
10. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

C. Interfaces with Other Work:

1. 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.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Panelboard Nameplates: Label each panelboard with nameplate.

C. Install warning signs.

D. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

E. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

F. Circuit Directory:

1. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic card holder.

a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by authorities having jurisdiction.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Perform optional tests. 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.

D. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION

SECTION 26 27 13.10.30

ELECTRIC METERING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Power Meters and CTs.

1.2 REFERENCE STANDARDS

A. IEEE C37.90.1

B. IEEE C57.13

C. IEC 61000-4-5

D. IEC 62053-22

E. ANSI C12.18

F. ANSI C12.20

1.3 SUBMITTALS

A. Submit manufacturer’s data for the following:

1. Power meter.
2. O&M manual.

PART 2 - PRODUCTS

2.1 Power Meters

A. Physical and Common Requirements

1. Power meters shall be semi-flush, back-connected. Meters shall be of a type that can be withdrawn through approved sliding contacts from fronts of panels or doors without opening current-transformer secondary circuits, disturbing external circuits, or requiring disconnection of any meter leads. Necessary test devices shall be incorporated within each meter and shall provide means for testing either from an external source of electric power or from associated instrument transformers or bus voltage. The meter shall have a digital face display plate,

shall display every electrical parameter indicated to be recorded, and shall be capable of scrolling through each parameter.
2. Surge withstand shall conform to IEEE C37.90.1.
3. Meter shall have a minimum 5 year warranty.
4. Meter shall comply with IEC 62053-22 (Part 21: Static Meter for Active Energy, classes 0.2S and 0.5S), certified by a qualified third party test laboratory.

B. Voltage Requirements:

1. Meter shall be capable of connection to the service voltage phases and magnitude being monitored. If the meter is not rated for the service voltage, provide suitable potential transformers to send an acceptable voltage to the meter.
2. Meter shall accept independent voltage inputs from each phase. Meter shall be auto-ranging over the full range of input voltages.
3. The Contractor shall be responsible for determining the actual voltage ratio of each potential transformer. Transformers shall conform to IEEE C57.13 and the following requirements:

    a. Type: Dry type, of two-winding construction.
    b. Weather: Outdoor or Indoor rated for the application.
    c. Frequency: Nominal 60 Hz.

C. Current Requirements:

1. Meter shall accept independent current inputs from each phase. Current transformer shall be installed with a full load rating.
2. Current transformer shall have:

    a. Insulation Class: All 600 volt and below current transformers shall be rated 10 KV BIL.
    b. Frequency: Nominal 60 Hz
    c. Burden: Burden class shall be selected for the load.
    d. Phase Angle Range: 0 to 60 degrees.

3. Meter shall accept current input from standard instrument transformers (5A secondary current transformers.)
4. Current inputs shall have a continuous rating in accordance with IEEE C57.13.
5. Current transformer shall conform to IEEE C57.13.

D. Electrical Measurements:

1. Power meter shall measure and report the following quantities:

    a. Kilowatt-hours (“kWh” in Metering Systems Schedule) of consumption.
    b. Kilowatts of demand (“kW” in Metering Systems Schedule) (average, min/max).
    c. Reactive power (“kVAR” in Metering Systems Schedule), (average, min/max).
    d. Real Power (“kVA” in Metering Systems Schedule), (average, min/max).
    e. Power factor (“PF” in Metering Systems Schedule), (average, min/max).
    f. Voltage (single and three phase) (min/max).

g. Amperage (single and three phase), (average, min/max).

2. Meter readings shall be true RMS.

E. Meter Accuracy:

1. Power meter and CT's shall have a combined maximum error of 3%.
2. Meter shall be revenue grade.

F. Communications:

1. The meter shall be connected to the existing MMAC JCI/Metasys system by the building automation contractor. The meter must be capable of displaying all electrical measurements on the MMAC Metasys system.
2. The meter shall have an RS485 port with ModBus protocol.
3. The meter shall have an on-board Ethernet connection.
4. The meter shall be BACnet MS/TP capable.

PART 3 - FIELD QUALITY CONTROL

3.1 TESTING

A. Meter shall be verified to be reading accurately following installation. To do this, the contractor shall provide a portable meter and physically connect the portable meter to obtain meter values. These values shall be compared to the values received remotely on Metasys. The government shall be present for the verification/commissioning of the new meter. Note that the contractor shall wear appropriate arc flash PPE when installing and removing any portable meters.

3.2 O&M TRAINING

A. The Contractor shall conduct a training course for meter configuration, operation, and maintenance of the system as specified. The training shall be oriented for all components and systems installed under this contract.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade duplex straight-blade receptacles.
3. Receptacles with ground-fault protective devices.
4. Locking receptacles.
5. Special-purpose power outlet assemblies.
6. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. General-use switches and dimmer switches.
2. General-grade duplex straight-blade receptacles.
3. Receptacles with ground-fault protective devices.
4. Locking receptacles.

B. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Switches and Dimmers.
2. Duplex straight-blade receptacles.
3. Receptacles with GFCI device.
4. Locking receptacles.

1.4 WARRANTY FOR DEVICES

A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

PART 2 - PRODUCTS

2.1 GENERAL-USE SWITCHES AND DIMMER SWITCHES

A. Toggle Switch:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

a. Reference Standards: UL CCN WMUZ and UL 20.

3. Options:

a. Device Color: Light Gray.
b. Configuration:
1) General-duty, 120-277 V, 20 A, single pole and three way.

4. Accessories:

a. Cover Plate: Stainless Steel; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. Dimmer Switch:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

a. Reference Standards: UL CCN EOYX and UL 1472 Type I dimmer.

3. Options:

a. Device Color: Light Gray.
b. Switch Style: Toggle.

c. Dimming Control Style: Slide.

4. Accessories:

a. Cover Plate: Stainless Steel; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.2 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

3. Options:

a. Device Color: Light Gray.
b. Configuration:

1) General-duty, NEMA 5-20R.

4. Accessories:

a. Cover Plate: Stainless Steel; from same manufacturer as wiring device.
b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

a. Reference Standards: UL CCN KCXX, UL 498, UL 943, UL 1699, and UL Subject 1699A.

3. Options:

    a. Device Color: Light Gray.
    b. Configuration: Heavy-duty, NEMA 5-20R.

4. Accessories:

    a. Cover Plate: Stainless Steel; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

B. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

1. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

    a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.

3. Options:

    a. Device Color: Light Gray.
    b. Configuration: Heavy-duty, NEMA 5-20R.

4. Accessories:

    a. Cover Plate: Stainless Steel; from same manufacturer as wiring device.
    b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.4 LOCKING RECEPTACLES

A. NEMA, 125 V, Locking Receptacle:

1. Regulatory Requirements:

    a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

    a. Reference Standards: UL CCN RTRT and UL 498.

3. Options:

a. Device Color: Black with yellow voltage indication on face.
b. Configuration: 2 pole, 3 wire, grounding, NEMA L5-20R.

B. NEMA, 250 V, Locking Receptacle:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

a. Reference Standards: UL CCN RTRT and UL 498.

3. Options:

a. Device Color: Black with blue voltage indication on face.
b. Configuration:

1) 2 pole, 3 wire, grounding, NEMA L6-20R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION OF SWITCHES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "Identification for Electrical Systems."

a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.

4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "Identification for Electrical Systems."

a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.4 INSTALLATION OF LOCKING RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "Identification for Electrical Systems."

    a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.5 FIELD QUALITY CONTROL OF SWITCHES

A. Tests and Inspections:

1. Perform tests and inspections in accordance with manufacturers' instructions.

B. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.6 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Acceptance Testing Preparation:

B. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.7 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.8 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.3 DEFINITIONS

A. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
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. Provide in PDF and Easy Power electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain products from single manufacturer.

B. 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.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSIBLE SWITCHES

A. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600 V(ac).
4. 200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses required by manufacturer.

6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. 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. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. 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. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: Enclosure must be gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (UL 50E Types 3R, 12).

C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.

D. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 1.

B. Outdoor Locations: UL 50E, Type 3R.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. 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.
2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Install fuses in fusible devices.

3.4 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 "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.

3.5 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the manufacturer’s written instructions.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Lightning protection system for ordinary structures.

B. Provide all labor, material, equipment, and services to perform operations required for the complete installation and related work as specified.

C. Any such work included in any other section of these specifications that is not generally described therein shall comply with the requirements of this section.

D. The following items of work are specifically included in, but not limited to the generality implied by these specifications:

1. ESE lightning protection air terminal.
2. Complete mast, base and supports.
3. Down Conductors.
4. Grounding terminations.

1.3 RELATED WORK

A. Nationally Recognized Testing Laboratory (NRTL) Inspection of Completed System:

1. The completed lightning protection system shall be inspected to the Installation Requirements for ESE Lightning Protection Systems US 17-102.
2. IEEE Fall of potential method for ground resistance testing.

1.4 ACTION SUBMITTALS

A. Product Data: For each product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.

2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

E. Submit Risk Assessment Per NFC 17-102 annex A; or UTE 17-108; or equivalent risk assessment yielding a protection level.

F. Submit EPA data per AASHTO code for the lightning protection mast(s) to be used on this project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 01 78 39 "Project Record Documents."
b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. UL Master Label Certificate or LPI Master Certificate.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: UL-listed installer, category OWAY or LPI Master Installer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.2 MATERIALS

A. Air Terminals:

1. Copper unless otherwise indicated.
2. Rounded tip.
3. Integral base support.

B. Air Terminal Bracing:

1. Copper.
2. 1/4-inch (6-mm) diameter rod.

C. Class I Main Conductors:

1. Stranded Copper: 57,400 circular mils in diameter.

D. Secondary Conductors:

1. Stranded Copper: 26,240 circular mils in diameter.

E. Ground Loop Conductor: Stranded copper.

F. Ground Rods:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch (19 mm).
3. Rods shall be not less than 120 inches (3050 mm) long.

G. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches (203 mm) in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet (60 m) of building. Comply with requirements for concealed systems in NFPA 780.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors or crimp.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.

END OF SECTION

SECTION 26 51 19

LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Highbay, nonlinear.
2. Recessed, linear.
3. Strip light.
4. Surface mount, linear.
5. Suspended, linear.
6. Materials.
7. Luminaire support.

B. Related Requirements:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 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.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each type of luminaire, for tests performed by a qualified testing agency.

D. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 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.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. 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.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Ambient Temperature: 41 to 104 deg F (5 to 40 deg C).

1. Relative Humidity: Zero to 95 percent.

B. Altitude: Sea level to 1000 feet (300 m).

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. Recessed luminaires shall comply with NEMA LE 4.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

2.3 HIGHBAY, NONLINEAR.

A. Nominal Operating Voltage: 277 V ac.

B. Lamp:

1. Minimum 24000 lm.
2. CRI of 80. CCT of 4000 K.
3. Rated lamp life of 60,000 hours to L70.
4. Internal driver.

5. Lens Thickness: At least 0.375-inch minimum unless otherwise indicated.

C. Housings:

1. Die-cast aluminum housing and heat sink.
2. White powder-coat finish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.4 RECESSED, LINEAR.

A. Nominal Operating Voltage: 277 VAC.

B. Lamp:

1. Minimum lumens as indicated on drawings.

2. CRI of 80. CCT of 4000 K.
3. Dimmable from 100 percent to zero percent of maximum light output.
4. Internal driver.
5. With integral mounting provisions.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.

2.5 STRIP LIGHT.

A. Nominal Operating Voltage: 277 V ac.

B. Lamp:

1. Minimum lumens as indicated on drawings.
2. CRI of 80. CCT of 4000 K.
3. Dimmable from 100 percent to zero percent of maximum light output.
4. Internal driver.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping of luminaire without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.6 SURFACE MOUNT, LINEAR.

A. Nominal Operating Voltage: 277 V ac.

B. Lamp:

1. Minimum lumens as indicated on drawings.
2. CRI of 80. CCT of 4000 K.

3. Dimmable from 100 percent to zero percent of maximum light output.
4. Internal driver.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.7 SUSPENDED, LINEAR

A. Nominal Operating Voltage: 277 V ac.

B. Lamp:

1. Minimum lumens as indicated on drawings.
2. CRI of 80. CCT of 4000 K.
3. Dimmable from 100 percent to zero percent of maximum light output.
4. Internal driver.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.8 MATERIALS

A. Metal Parts:

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

B. Steel:

1. ASTM A36/A36M for carbon structural steel.

2. ASTM A568/A568M for sheet steel.

C. Stainless Steel:

1. Manufacturer's standard grade.
2. Manufacturer's standard type, ASTM A240/240M.

D. Galvanized Steel: ASTM A653/A653M.

E. Aluminum: ASTM B209.

2.9 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.

2.10 LUMINAIRE SUPPORT

A. Comply with requirements in Section 26 05 29 "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 (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) 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. Install lamps in each luminaire.

D. 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.

E. 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.

F. Wall-Mounted Luminaires:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaires:

1. Ceiling Mount:

   a. Two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length.
   b. Pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length.
   c. Hook mount.

2. Pendants and Rods: Where longer than 48 inches (1200 mm), 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. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. 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 and building structure in a minimum of four locations, spaced near corners of luminaire.

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 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 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps 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

SECTION 26 52 13

EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Emergency lighting.
2. Exit signs.
3. Materials.
4. Luminaire support components.

1.3 DEFINITIONS

A. Correlated Color Temperature (CCT): The absolute temperature, measured in kelvins, of a blackbody whose chromaticity most nearly resembles that of the light source.

B. Color Rendering Index (CRI): Measure of the degree of color shift that objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source.

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. Lumen (lm): The SI derived unit of luminous flux equal to the luminous flux emitted within a unit solid angle by a unit point source (1 lm = 1 cd-sr).

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of emergency lighting unit, exit sign, and emergency lighting support.

a. Include data on features, accessories, and finishes.

b. Include physical description of unit and dimensions.
c. Battery and charger for light units.
d. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
e. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.

B. Shop Drawings:

1. For nonstandard or custom luminaires.

a. Include plans, elevations, sections, and mounting and attachment details.
b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Include diagrams for power, signal, and control wiring.

C. Samples: For each product and for each color and texture specified.

D. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.

E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of luminaire.

B. Product Test Reports: For each luminaire for tests performed by, or under supervision of, qualified luminaire photometric testing laboratory.

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. Luminaire-mounted, emergency battery pack: One for every 10 emergency lighting units. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. FM Global Compliance: Luminaires for hazardous locations must be listed and labeled for indicated class and division of hazard by FM Global.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Special Installer Extended Warranty for Emergency and Exit Lighting: Installer warrants that fabricated and installed emergency luminaires and exit signs, including batteries, perform in accordance with specified requirements and agrees to repair or replace components and assemblies that fail to perform as specified within extended warranty period.

B. Special Manufacturer Extended Warranty for Batteries for Emergency and Exit Lighting: Manufacturer warrants that batteries for emergency luminaires and exit signs perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within extended warranty period.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with NFPA 101.

C. Comply with NEMA LE 4 for recessed luminaires.

D. Comply with UL 1598 for fluorescent luminaires.

E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Emergency Connection: Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
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. 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.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EMERGENCY LIGHTING

A. General Characteristics: Self-contained units.

B. Emergency Luminaire:

1. Options:

    a. Operating at nominal voltage of 277 V(ac).
    b. Internal emergency power unit.
    c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.

C. Emergency Lighting Unit:

1. Options:

    a. Operating at nominal voltage of 277 V(ac).
    b. Wall with universal junction box adaptor.
    c. UV stable thermoplastic housing, rated for damp locations.
    d. Two LED lamp heads.
    e. Internal emergency power unit.

2.3 EXIT SIGNS

A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Sign:

1. Options:

a. Operating at nominal voltage of 277 V(ac).
b. Lamps for AC Operation:
   1) LEDs; 50,000 hours minimum rated lamp life.

c. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.4 MATERIALS

A. Metal Parts:

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

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

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 range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 0.106 inch (2.69 mm).

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. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

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

3.2 INSTALLATION

A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

B. 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 must 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.

C. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

D. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inch (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. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Ceiling Grid Mounted Luminaires:

1. Secure to outlet box, if provided.
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 FIELD QUALITY CONTROL

A. 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. Nonconforming Work:

1. Luminaire will be considered defective if it does not pass operation tests and inspections.
2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

D. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.4 SYSTEM STARTUP

A. Perform startup service:

1. Charge batteries minimum of one hour and depress switch to conduct short-duration test.
2. Charge batteries minimum of 24 hours and conduct one-hour discharge test.

3.5 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect luminaires. Replace emergency power units, batteries, exit signs, and luminaires that are defective.

a. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

3.6 PROTECTION

A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

END OF SECTION

SECTION 26 56 19

LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Luminaire types.
2. Materials.
3. Finishes.
4. Luminaire support components.

B. Related Requirements:

1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP 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.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

D. Delegated Design Submittals: For luminaire supports.

1. Include design calculations for luminaire supports.

1.5 INFORMATIONAL SUBMITTALS

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

1. Luminaires.
2. Above-grade utilities and structures.
3. Existing above-grade utilities and structures.
4. Building features.
5. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

D. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

E. Source quality-control reports.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 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.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 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. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

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

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

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. CRI of 80. CCT of 3000 K.

F. Internal driver.

G. Nominal Operating Voltage: 277 V ac.

H. Lamp Rating: Lamp marked for outdoor use.

I. Source Limitations:

1. Obtain luminaires from single source from a single manufacturer.
2. 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 (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) 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. Area and Site:

1. Luminaire Shape: Square.
2. Mounting: Building.
3. Luminaire-Mounting Height: 9 ft.
4. Distribution: Type II.
5. Housings:

a. Extruded-aluminum housing and heat sink.
b. Clear powder-coat finish.

2.4 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

F. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

G. 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.

1. Label shall include the following lamp characteristics:

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

2.5 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. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

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.

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. Examine walls and roofs for suitable conditions where luminaires will be installed.

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

3.2 TEMPORARY LIGHTING

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Install lamps in each luminaire.

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. Attached to structural members in walls.

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 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 33.13 "Conduits for Electrical Systems" for wiring connections and wiring methods.

3.4 INSTALLATION OF BOLLARD LUMINAIRES

A. Align units for optimum directional alignment of light distribution.

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 05 33.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 IDENTIFICATION

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

3.7 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. Photoelectric Control Operation: Verify operation of photoelectric controls.

C. Illumination Tests:

1. 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.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps 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 Architect.

END OF SECTION

DIVISION 27

Telecommunications Standards for the Mike Monroney Aeronautical Center

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Revision History		
Rev	**Description of Change**	**Effective Date**
	Update position configuration and equipment list.	**08/01/2012**
8	Update equipment list, jack labeling, routing symbols, document name and file name.	02/03/2014
9	Updated Sections 2, 3, 4, 5 & 9	01/18/2016
	Updated document number and reference document numbers	
10	Added Single Mode Fiber	06/13/2016
11	Added Media Converter Equipment	11/23/2016
12	Update Sections 2.2.1.4.3 and 4.1.5.3	07/23/2017
13	Update Section 1.6.3, 2.2.1.5.1, 2.2.1.6.1, 2.2.1.6.2, 3.1, 5.1.2, 7.14 and 9.1.1.1.9	05/24/2018
14	Removed outdated references	01/11/2019
15	Updated routing symbol from AMK-222A to AMK-224 throughout entire document Updated DAS Equipment List 2.2.1.6.2 Removed 1.8.7 Installer certification	06/14/2021 07/01/221
16	Updated Sections 2.2.1.4.3, 2.2.1.5.1, 4.1.5.3, 4.1.5.4	11/01/2022
17	Updated Sections 2.2.1.6.2, 7.13	04/16/2024

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DIVISION 27 – TELECOMMUNICATIONS

SECTION 27000 – GENERAL PROVISIONS FOR TELECOMMUNICATIONS SPECIFICATIONS

CONSTRUCTION STANDARD

1. PART: GENERAL

1.1. SECURITY

Telecommunications Security – For reasons of security and separation of function, independent networks of other agencies, tenant organizations, private companies, etc. located within the Mike Monroney Aeronautical Center shall have independent network cable totally isolated from any FAA infrastructure (to include data, analog or voice). At the least, isolated conduit and separate positions at the user location are required. Other requirements may include separate closets. It is a requirement for the independent network cable and jack to have colors different than that in use by the FAA network/voice cables and other independent existing networks. Therefore, coordination with the Telecommunications Unit (AMK-224) is required in planning of all network connectivity for all organizations, agencies, tenant organizations, or private companies occupying space at the Mike Monroney Aeronautical Center.

1.2. RELATED DOCUMENTS

1.2.1. Drawings and general provisions, including General and Supplementary Conditions and General Requirements (if any), are hereby made a part of this Section. Refer to paragraph titled "Telecommunications Subcontractor Qualifications" in this section for requirements for Telecommunications Subcontractors. Throughout this and related Sections, "Subcontractor" shall not be limited to the singular and masculine and shall refer to one, or more than one, Telecommunications Subcontractor(s).

1.3. REFERENCE SPECIFICATIONS, STANDARDS AND CODES

1.3.1. Comply with the referenced codes and standards within this document. Where conflicts occur, the more stringent shall apply.

1.3.2. Work shall meet or exceed the standards and procedures of the following:
American National Standards Institute (ANSI)
Telecommunications Industries Association (TIA)
Electronic Industries Association (EIA)

National Electrical Manufacturers Association (NEMA)
National Electrical Safety Code (NESC)
Institute of Electrical & Electronics Engineers (IEEE)
Underwriters Laboratories (UL)
National Fire Protection Association (NFPA)
American Standards Association (ASA)
Federal Communications Commission (FCC)
Occupational Safety and Health Administration (OSHA)
American Society of Testing Material (ASTM)
National Electric Code (NEC)
Americans with Disabilities Act (ADA)

In the event of conflicts, the more stringent provisions shall apply.

1.3.3. Construction Project Manager (CPM): As defined for Sections referring to telecommunications work only; the CPM shall be the design analyst employed by the FAA for the purpose of observing the work of the Telecommunications Subcontractor.

1.3.4. All Indefinite Delivery Requirements (IDR) contract work shall be turn-key. Telecommunications technicians shall perform all telecommunications work to include testing telecommunications cables prior to pull (fiber), pulling telecommunications cables (copper and fiber), testing telecommunications cables after pull (copper and fiber), termination of telecommunications cables (copper and fiber) and final testing. Test results and as-built drawing to include telecommunications position numbers shall be provided to AMP-400. AMP-400 will provide test results and as-built drawings to include telecommunications position numbers to AMK-224 for approval and acceptance, prior to personnel occupying renovated or newly constructed area.

1.4. COORDINATION

1.4.1. When articles, materials, operations or methods related to execution of telecommunications work are noted, specified, or described in the specifications of, are indicated or reasonably implied on drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.

1.4.2. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions, nor will they identify inclusion of specific accessories, appurtenances, and related items necessary and appropriate for a complete and proper installation and operation. The Telecommunications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed in accordance with the intent diagrammatically expressed on

the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Telecommunications Unit, Telecommunications Infrastructure Planning Team (TIPT). When abbreviations appear on the drawings or specifications in upper- or lower-case letters, with or without periods, the resultant work shall be as stated above.

1.4.3. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Telecommunications Subcontractor.

1.4.4. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.5. DESCRIPTION OF SYSTEMS

1.5.1. Furnish and install materials for the Telecommunications Infrastructure systems as specified herein and as shown on the drawings. Upon completion, the systems shall be functioning systems in compliance with performance requirements specified.

1.5.2. The cabling specified and shown on the drawings is for complete, performance based, workable systems. Deviations from the cabling shown due to a particular manufacturer's requirements shall be made only with the written approval of the FAA and at no additional cost to the FAA.

1.6. SUBMITTALS

1.6.1. Submittals shall be made as one complete package. Submittals for equipment shall be provided to AMK-224 for review prior to purchase/installation.

1.6.2. Submittals for individual systems and equipment assemblies, which consist of more than one item or component, shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the Contractor.

1.6.3. Generate shop drawings on AutoCAD. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings in hard copy and an electronic copy. Electronic copies are to be written to a USB device if they cannot be provided through a shared drive.

1.6.4. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.

1.7. RECORD DRAWINGS

1.7.1. Provide Record Drawings for requirements regarding Project Record Documents. "As-Built" record documentation for telecommunications work shall include:

System function diagrams
Manufacturers' description literature for equipment
Connection and programming schedules as appropriate
Equipment material list including quantities
Spare parts list with quantities
Details not on original Contract Documents
Test Results
Warranties
Release of Liens

1.7.2. Operation and Maintenance Manual:

1.7.2.1. The Telecommunications Subcontractor shall submit manuals that will contain manufacturers' brochures of items installed by the Telecommunications Subcontractor.

1.7.2.2. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate specification sections.

1.7.2.3. Provide the following additional information for each electronic system. Information shall be edited for projects where applicable.

- Operations manuals for components and for system as a whole.
- Maintenance Manuals for components and for system as a whole.
- Point-to-point diagrams, cabling diagrams, construction details and cable labeling details.
- List of spare parts, materials and suppliers of components.
- Provide name, address and telephone number for each supplier.
- Emergency instructions for operational and maintenance requirements.
- Delivery time frame for replacement of component parts from suppliers.
- Recommend inspection schedule and procedures for components and for system as a whole.

- Complete "Reviewed" shop drawings and product data for components and system as a whole.
- Troubleshooting procedures for each system and for each major system component.

1.8. QUALITY ASSURANCE

1.8.1. Equipment and materials required for installation under these specifications shall be the current model and new (less than one year from date of manufacture), unused and without blemish or defects.

1.8.2. Manufacturers of equipment and materials, pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three years.

1.8.3. Provide a written quality assurance plan for approval by the FAA including testing, plan for pre-testing and for final testing and certification of pre-testing and commissioning prior to final testing. Ensure compliance with Contract Documents. Include back-check as part of testing plans.

1.8.4. Manufacturers: Firms regularly engaged in the manufacture of cable and devices of the types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.8.5. EIA/TIA Compliance: Comply with applicable portions of Telecommunications Industry Association/Electrical Industry Association standards pertaining to cable, wire, and connectors.

1.8.6. UL Labels: Provide cable, wire, and connectors, which have been approved, listed and labeled by Underwriters Laboratories.

1.9. TELECOMMUNICATIONS SUBCONTRACTOR QUALIFICATIONS

1.9.1. General: The telecommunications subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the telecommunications drawings and specifications. The telecommunications subcontractor shall be a company specializing in the design, fabrication, and installation of integrated telecommunications systems.

1.9.2. Telecommunications systems specified shall be engineered, assembled and installed under the direction of a pre-qualified telecommunications subcontractor. Pre-qualification requirements shall include submittal by the telecommunications subcontractor to the architect of the following:

1.9.2.1. List of previous projects of this scope and nature, including names and sizes of projects, description of work, time of completion, and name of contact persons for reference.

1.9.2.2. Installers shall certify that they are manufacturer-authorized for work to be performed.

1.10. COORDINATION WITH OTHER TRADES

1.10.1. The telecommunications subcontractor shall coordinate telecommunications work with that of other sections as required ensuring that the entire telecommunications work will be carried out in an orderly, complete and coordinated fashion.

1.11. WARRANTY

1.11.1. Warranty work is to be free from defects. Repair or replace defective materials or workmanship, as well as damage to the work of other trades resulting from same, as directed by the FAA for the duration of the stipulated warranty period.

1.11.2. The primary suppliers of telecommunications hardware and software shall warranty, through the telecommunications subcontractor, in writing, phases of systems (including but not limited to, software, hardware, and peripheral equipment) against defective materials, design and workmanship. Upon receipt of notice from the FAA of failure of the system, or parts thereof, the telecommunications subcontractor, with the assistance of the supplier, shall promptly restore the defective component to provide an acceptable system at no cost to the FAA. The telecommunications subcontractor shall warranty the performance of the system for its intended

use for a period of 1 year from the date of final acceptance and shall "pass-through" and shall activate the manufacturers' warranties to the FAA for the full extent and period of the manufacturer's warranty.

1.11.3. The warranty period shall commence upon final acceptance of the work by the FAA. Acceptance tests and procedures shall be developed by the telecommunications subcontractor in accordance with the provisions of this specification and accepted by the FAA. The telecommunications subcontractor shall test the installed systems in accordance with the accepted test procedures.

1.11.4. Acceptance by a manufacturer of an order for equipment for this contract signifies acceptance of specified warranty requirements.

1.11.5. During the warranty period, there shall be no charges to the FAA for service calls (mileage, labor, travel, expenses, etc.) for warranty related work.

1.12. DESCRIPTION OF WORK

1.12.1. The extent of telephone and data work is indicated by drawings and schedules, and by the requirements of this section.

1.12.2. The types of components required for the project include the following:

Riser Cable – Fiber and Copper

Station Cable

Jacks and Mounting Frames

Termination Equipment – Fiber and Copper

Product Data: Cable, jacks, termination equipment and accessories

All above equipment is contractor furnished and installed on all IDIQ projects.

1.13. SUBMITTALS

1.13.1. The FAA Telecommunications Unit TIPT must approve any proposed substitutions for the specified telecommunications cable. Proposed substitutions are to be coordinated through AMP-400.

2. PART: PRODUCTS

2.1. GENERAL

2.1.1. For each system, provide all wire, cable, jacks, termination accessories and other components as required to form a complete system of the types indicated or specified.

2.2. MATERIALS

2.2.1. Manufactured Products:

2.2.1.1. Material and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

2.2.1.2. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer.

2.2.1.3. Equipment Assemblies and Components:

2.2.1.3.1. Components of an assembled unit need not be products of the same manufacturer but must meet TIA/EIA Category 6 criteria as a complete link system.

2.2.1.3.2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

2.2.1.3.3. Components shall be compatible with each other and with the total assembly for the intended service.

2.2.1.3.4. Moving parts or elements of equipment of the unit normally requiring lubrication shall have means provided for such lubrication and shall be adequately lubricated at the factory prior to delivery.

2.2.1.3.5. Factory cabling shall be identified on the equipment being furnished and on cabling diagrams.

2.2.1.4. Cable:

2.2.1.4.1. Fiber Optic Riser Cable:

- ❖ 50 Micron Indoor or Outdoor Fiber Riser Rated Cable (as determined, whether plenum or non-plenum cable is required) or approved equal (number of strands to be supplied by AMK-224).
- ❖ Multimode and single mode (number of multimode and single mode to be supplied by AMK-224).

2.2.1.4.2. Copper Telecommunications Riser Cable:

- ❖ 24 AWG, Level 3, Anixter # CMR-02004EAA (number of pair to be supplied by AMK-224)

2.2.1.4.3. Station Cable

- ❖ 2 cables to each position, level 6, 24 gauge, 4 pair, for two RJ-45 LAN connections (orange jacks).

2.2.1.5. Telephone and Data Receptacles:

2.2.1.5.1. Provide each telephone and data outlet with the following components (proposed substitutions must be submitted to AMK-224 for review prior to purchase/installation):

Description	Comcode Number
2 ea. – RJ-45 Connector (Orange)	MGS400BH-112
2 ea. – Blank	107067860
1 ea. – Frame	106622277

2.2.1.6. Telephone and Network Equipment:

2.2.1.6.1. Figure two ports for every position reflected on the project.

2.2.1.6.2. Provide and install the following equipment as required (report any substitution prior to purchase/installation to AMK-224):

Description	Comcode/Part Number	Unit
Original Distributed Antenna System Cellular Equipment		
Andrew Cellmax-D-CPUSF	20008570	EA
Trilogy 50ohm N Female Connector	NFP01250	EA
2' RG-142 N Male to N Male	CXTA42A-2	EA
2F Zipcord Riser SC-APC to SC-APC 6'	666602G5120006F	EA
1U Pretium Connector Fiber Housing	500001652	EA
Microlab 2 Way Splitter (698-2700mhz)	D2-69FN	EA
Universal Plug & Play Module (SCAPC)	500001738	EA
N Female Connector for ½"	TRG-NFP01250	EA
½ Plenum Coax	AP6012 J 50	FT
The One Distributed Antenna System Cellular Equipment		
System Controller	SC-450	EA
Power Attenuation Unit w/6 Broadband Attenuators	WB-PAU-6	EA
PAU-6 to RIU Cables Kit, 6 QMA to QMA	AK-PAU-6-RIU-CABLES	EA
1-HEU, 2-RIX, 1-PSM-AC, 1-HCM	HEU-2-00-1-A-H	EA
1-HEU, 2-RIX, 1-PSM-AC, 1-ACM	HEU-2-00-2-A-A	EA
RIM Radio Interface Module – CELL	RIM-C85	EA
RIM Radio Interface Module – PCS	RIM-P19	EA
RIM Radio Interface Module AWS	RIM-A17	EA
RIM Radio Interface Module LTC	RIM-L70	EA
1-OIU, 2-OIX, 1-PSM-AC, 1-ACM	OIU-2-00-2-A-A	EA
Optical Interface Unit (OIU) Chassis 1-OIU, 2-OIX, 1-PSM-AC, 1-ACM	OIU-2-00-1-A-A	EA
OIM Optical Interface Module	OIM	EA
ERFC60 Extender RF Cable 24 INCH	ERFC24	EA
HEU, OIU, CABLE MANAGEMENT TRAY & DOOR SLEEVE	CBLTRAY	EA
Corning Remote Access Unit (RAU) Supporting 5 bands: LTE 700, ESMR 800/Cell 850, PCS1900 & AWS + AWS3 1700	RAU5XUS	EA
ICU, 1 EDGE Module, 1 PSM-1	ICU-12-M-12-AF-0-1	EA
ICU, One Pretium EDGE Modules, 2 PSM-I	ICU-12-M-12-AF-0-2	EA
ICU 2 EDGE Module, 1 PSM-1	ICU-24-M-12-AF-0-2	EA
Interconnect Unit (ICU) Housing	ICU-1U	EA
V-Pol Omni Antenna 698 2700MHz (Antenna)	TRU Omni R727	EA
LMR400 N-Male to QMA Male, 15 FT (Connector)	CXTA40WR-XX	EA
LC/APC Edge Module	ECM-UM12-18-896	EA
Pretium EDGE* Solutions Housing 1 Rack Unit Holds 12	EDGE-O1U-SP	EA
ONE Composite Tether, 6F/4Cu, 16AWG, Plenum Cable Non Armored	HR1818H4CO6U820200F	EA (Based on required length)

Description	Comcode/Part Number	Unit
ActiFi™ DAS Cables for Indoor Plenum, 6 F, 4 Cu Conductor, 16AWG	006UT8-41H01M20	EA
MiniXtend Cables with Binderless FastAccess Technology, 144 SM, 10K Feet Spool	144ZM4-T4F22A20	EA
Corning® SMF-28® Ultra 200 µm Fiber - MiniXtend Cables with Binderless FastAccess Technology, 48 SM	048ZM4-T4F22A20	EA
Fiber Optic Cleaning Tool, MTP® Connectors	2104466-01	EA
Common Interface Modules (HEU & OIU) Extender RF Cable, 16 in	ERFC16	EA
Common Interface Modules (HEU & OIU) Extender RF Cable, 34 in	ERFC34	EA
Common Interface Modules (HEU & OIU) Extender RF Cable, 40 in	ERFC40	EA
Common Interface Modules (HEU & OIU) Extender RF Cable, 59 in	ERFC59	EA
Fiber Optic Cleaning Fluid	FCC-CLEANER-FIBER	EA
Fiber Link Main Module	FMM	EA
Fiber Link Remote Module	FRM	EA
ONE, Composite Tether, 6F/4Cu, 16AWG, Plenum, Non-Armored 170'	HR1818H4C06U820170F-PK	PK
Corning ONE Composite Tether - length 320'	HR1818H4C06U820320F-PK	PK
Corning ONE Composite Tether - length 623'	HR1818H4C06U820630F-PK	PK
Headend Unit (HEU) Chassis	IHU-2-11-2-A-A	EA
Spider Fan-Out Kit Insert, 3.0 mm, 900 µm, 6 fibers, yellow	INS-06F-900-3-Y	EA
Local AC/DC Converter 100W	LPS-48V-100W	EA
Splice Tray, Heat-shrink Fusion Splices, Clear cover, 0.2 in, 12 F	M67-048-C	EA
Interconnect Unit (ICU) Power Supply Module	PSM-I	EA
Power Supply Unit with no PSM-I installed. Can accommodate up to 6 total PSM-I	PSU6-1U	EA
Remote Antenna Unit for 700LTE/Cell/PCS/AWG	RAU-C85P19L70A17	EA
Headend Unit (HEU) Modules Corning ONE Radio Interface Module, ESMR 800MHz	RIM-E80	EA
VFL Adapter, High-Performance Installation Tool, LC	VFL-A125	EA
VFL Adapter, High-Performance Installation Tool, SC/ST® compatible	VFL-A250	EA

Description	Comcode/Part Number	Unit
100 PR Building Entrance Protector	107894925	EA
110-C5	103801254	Pack
15 Foot BL CAT6 Patch Cord	EV06-15-BL	EA
15 Foot GY CAT6 Patch Cord	EV06-15-GY	EA
15 Foot YL CAT6 Patch Cord	EV06-15-YL	EA
188 w/Legs	104405113	EA
19" Rack	46353-503	EA
1U Rack Mountable Fiber Box	CCH-01U	EA
24 Port Patchmax CAT6	760102251	EA
Patch Panel, Modular Cat 6, 48-Port,	760207282	EA
Patch Panel, Modular Cat 6, 24-Port,	760207274	EA
25 Foot BL CAT6 Patch Cord	EV06-25-BL	EA
25 Foot GY CAT6 Patch Cord	EV06-25-GY	EA
25 Foot YL CAT6 Patch Cord	EV06-25-YL	EA
2U Rack Mountable Fiber Box	CCH-02U	EA
300 Pair Block w/Legs	107059917	EA
CCH Panel, LC Adapters, Duplex, UPC, 24 F, Single mode	CCH-CP24-A9	EA
CCH Panel, LC adapters, Duplex, 24 fiber, 50 µm mm OM3/4	CCH-CP24-E4	EA
General Cable Cat 6 Gen Speed	7133800	FT
48 Port Patchmax CAT6	760128207	EA
5 Foot BL CAT6 Patch Cord	EV06-05-BL	EA
5 Foot GY CAT6 Patch Cord	EV06-05-GY	EA
5 Foot YL CAT6 Patch Cord	EV06-05-YL	EA
1 Meter LC/LC Fiber Patch Cable, 10G OM3, Duplex, 1.8mm PVC Aqua	Generic Corning Glass	EA
2 Meter LC/LC Fiber Patch Cable, 10G OM3, Duplex, 1.8mm PVC Aqua	Generic Corning Glass	EA
3 Meter LC/LC Fiber Patch Cable, 10G OM3, Duplex, 1.8mm PVC Aqua	Generic Corning Glass	EA
5 Meter LC/LC Fiber Patch Cable, 10G OM3, Duplex, 1.8mm PVC Aqua	Generic Corning Glass	EA
10 Meter LC/LC Fiber Patch Cable, 10G OM3, Duplex, 1.8mm PVC Aqua	Generic Corning Glass	EA
1 Meter LC/LC Fiber Patch Cable, MM-62.5/125, Duplex, 1.8mm PVC Orange	Generic Corning Glass	EA
2 Meter LC/LC Fiber Patch Cable, MM-62.5/125, Duplex, 1.8mm PVC Orange	Generic Corning Glass	EA
3 Meter LC/LC Fiber Patch Cable, MM-62.5/125, Duplex, 1.8mm PVC Orange	Generic Corning Glass	EA
5 Meter LC/LC Fiber Patch Cable, MM-62.5/125, Duplex, 1.8mm PVC Orange	Generic Corning Glass	EA

10 Meter LC/LC Fiber Patch Cable, MM-62.5/125, Duplex, 1.8mm PVC Orange	Generic Corning Glass	EA
1 Meter LC/LC Fiber Patch Cable, SM-9/125, Duplex, 1.8mm PVC Yellow	Generic Corning Glass	EA
Description	**Comcode/Part Number**	**Unit**
2 Meter LC/LC Fiber Patch Cable, SM-9/125, Duplex, 1.8mm PVC Yellow	Generic Corning Glass	EA
3 Meter LC/LC Fiber Patch Cable, SM-9/125, Duplex, 1.8mm PVC Yellow	Generic Corning Glass	EA
5 Meter LC/LC Fiber Patch Cable, SM-9/125, Duplex, 1.8mm PVC Yellow	Generic Corning Glass	EA
10 Meter LC/LC Fiber Patch Cable, SM-9/125, Duplex, 1.8mm PVC Yellow	Generic Corning Glass	EA
Cable Runway Ladder Rack 9' x 11.5" x 12'	CPI 10250-712	EA
Avaya 6 Port Face Plate	108168592	Pack
Berk-Tek CAT6 Four Pair Station Cable Non-Plenum	10136339	FT
Blue Label	106657174	Pack
Bulkhead Flange Adapter	38195	EA
Butt Splice Kit	CPI 11301-001	EA
But Splice Kit UL Classified Gold	16301-001	EA
Cable Management Racks	11729-703 Black	EA
Cable Mount	TMEH-58-C0	Pack
Cable Runway End Caps	CPI 10642-001	Pack
Cable Runway J-Bolt Kit, Runway to Wall Support Bracket	CPI 11308-001	EA
Cable Runway Junction Splice Kit Gold	CPI 16302-001	EA
Cable Runway Ladder Rack 9' x 11.5" x 12'	CPI 10250-712	EA
Cable Runway Mounting Plate 12" w/Angle Support Kit	CPI 11421-712	EA
Endplate	8003542	EA
Fiber Cable Management	CJP-02U	EA
Fiber Fan-Out Kit	FAN-BT25-12	EA
Fiber Rack Mountable Enclosure	CCH-04U	EA
Grounding Kit for 7' Rack	CPI 41026-001	EA
J-Bolt Kit	CPI 11308-001	EA
Jumper Trough Block	107831141	EA
LC Fiber Panel	CCH-CP12-E4	EA
LC MM Fiber Connectors	95-050-99	EA
LC SM Fiber Connectors	95-200-99	EA
LC SM Fiber Panel	CCH-CP12-A9	EA
12-Fiber LC SM Pigtail Kit	UPPLC-KIT	EA
Quad Frame	106622277	EA
Rack to Runway Mounting Plate	CPI 10595-712	EA
Rack to Runway Mounting Plate for 9" to 12"	CPI 10595-112	EA

ST Connectors	95-100-01R	EA
Media Converter Equipment		
19-Slot Chassis for ION Slide-in Modules Rack mountable chassis	ION219-A	EA
6-Slot Chassis for ION Slide-in Modules Rack mountable chassis	ION106-A	EA
AC Power Supply Module for the ION 6-Slot Chassis Redundant AC power supply for ION 6-Slot Chassis, 100 to 240 VAC input (2 per chassis)	IONPS6-A	EA
Redundant AC Power Supply for 19-Slot ION Chassis, 100 to 240 VAC input (2 per chassis)	IONPS-A	EA
ION T1/E1 Network Interface Device Module T1/E1 over Fiber Twisted Pair (RJ-48) 1.5 km/0.9 mi. to 1310nm single mode (SC) 20 km/12.4 mi. Link Budget: 16.0 dB	C6010-1014	EA
ION Face Plate ION FACEPLATE TO COVER EMPTY SLOTS (REQUIRED)	IONFP	
Redundant AC Power Supply for 19 Slot ION Chassis	IONPS-A-R1	EA
100 Base TX (RJ-45) (100 m/328 ft.) to 100 Base FX 1310 nm single mode (LC) (20 km/12.4 mi) Link Budget: 17.3 dB	C2110-1019	EA
10/100 Base TX (RJ-45) (100m/328 ft.) to 100 Base FX 1300 nm multimode (LC) (2 km/1.2 mi.) Link Budget: 11.0 dB	C2210-1039	EA
ION Gigabit Ethernet Media Converter Module 1000Base-T (RJ-45) 100 m/328 ft. to 1000Base-X SFP Slot (empty)	C3110-1040	EA
MSA Compliant 1000Base Fiber Channel SFP Modules 1000Base-LX Single Mode (LC) 1000Base-LX 1310nm single mode (LC) with DMI 30 km/18.6 mi. Link Budget: 19.0 dB	TN-SFP-LX3	EA

3. PART: EXECUTION

3.1. INSTALLATION

3.1.1. Telecommunications outside duct bank shall be concrete encased and buried a minimum of 36" below the ground surface. Concrete shall have a minimum strength of 3,000 psi at 28 days. Marker tape shall be plastic, vinyl, or Mylar, 6 inches wide, and shall be orange to denote telecommunications duct bank, and labeled to indicate the type of circuit buried below. Any deviation to be approved by AMK224 Telecommunications Infrastructure Planning Team (TIPT).

3.1.2. Install telephone and data products in accordance with the manufacturer's written instructions, the applicable requirements of TIA/EIA, and in accordance with recognized industry practices to ensure that products serve the intended function.

3.1.3. All telephone and data cables shall be installed in conduit per blueprint requirements. The established minimum conduit size is 1".

3.1.3.1.1. Cable Fill Ratio Table

Conduit Trade Size	**EMT** Capacity Area - 40% fill (SQ IN)	# of Cables for a 40% Fill CAT 6	**RGS** Capacity Area - 40% fill (SQ IN)	# of Cables for a 40% Fill CAT 6	**PVC** Capacity Area - 40% fill (SQ IN)	# of Cables for a 40% Fill CAT 6
1"	0.346	8	0.355	8	0.333	8
1 1/4"	0.598	14	0.61	14	0.581	14
1 1/2"	0.814	19	0.829	20	0.794	19
2"	1.342	32	1.363	32	1.316	31
2 1/2"	2.343	55	1.946	46	1.878	44
3"	3.538	84	3.000	71	2.907	69
3 1/2"	4.618	109	4.004	95	3.895	92
4"	5.901	140	5.153	122	5.022	119

Cat 6 Diameter .232 in

3.1.3.2. Bond riser cables to the ground bar at both ends.

3.1.3.3. Terminate all pairs and fiber strands of riser cables.

3.1.3.4. Contractor shall mount racks in telephone rooms and equipment in the racks as specified in the MMAC Telecommunications Generic Specifications Section. Configuration and turn-up shall be accomplished by FAA, AMK-224.

3.1.3.5. Installation of all termination equipment and other work in telephone equipment room shall be accomplished under the direction of an FAA AMK-224 representative. Bundle cables and secure with Velcro hook & loop, and provide ladder rack as required to neatly train all cables. Label all cables in accordance with FAA standard nomenclature using approved labeling material as specified in the Jack Labeling Section.

3.1.3.6. Fiber Optic splices shall not be allowed unless specifically called for on the drawings or preapproved by AMK-224. Where fiber optic splices are specifically called for, provide

fusion splices. Maximum allowable splice attenuation for single-mode or multi-mode fiber shall be 0.05 dBs. Submit printout documentation showing the dB loss in the splice of each strand.

3.1.3.7. Junction Boxes shall be 18"x18"x10". If the stated size box cannot be installed due to space restrictions, contact AMP-400. AMP-400 will consult with the Voice/Data Communications team of the Telecommunications Unit at 954-3651 to submit request for substitution with the next appropriate size junction box.

3.1.3.8. Turns in conduit shall be wide sweep turns with no bend in conduit greater than 90° or an aggregate of bends in excess of 180° between pull points or pull boxes. For runs that total more than 100 feet in length, pull points or pull boxes shall be inserted so that no segment between points/boxes exceeds the 100-foot limit. Any turn greater than 90° will require installation of a junction box. If a junction box is required, contact AMP-400. AMP-400 will contact Voice/Data Communications team of the Telecommunications Unit at 954-3651 for determination of junction box size requirement. **Conduit shall be bonded to ground on one or both ends.**

3.2. EXAMINATION OF SURFACE CONDITIONS

3.2.1. Prior to the start of work, the telecommunications subcontractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.

3.2.2. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.

3.2.3. In the event of discrepancy, immediately notify the AMP-400 Project Manager.

3.2.4. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.3. TESTING

3.3.1. Fiber Optic Cable Testing:

3.3.1.1. Contractor shall perform an Optical Time Domain Reflector (OTDR) test to verify integrity of the cable when received from the manufacturer (test cable on the reel) and again to ensure the cable was not damaged during the installation.

3.3.1.2. Contractor shall perform an end-to-end attenuation test to verify proper termination of each fiber.

3.3.1.2.1.1. Contractor shall submit each test to AMP-400 for acceptance and approval by the FAA. AMP-400 shall provide test results to AMK-224 for review and approval. Contractor shall replace any defective or noncompliant cable at no additional cost to the FAA.

3.3.2. OTDR Testing:

3.3.2.1. Upon delivery of the cable to the jobsite, and prior to installation, test each strand of cable with Optical Time Domain Reflectometer (OTDR) with multi-mode and single-mode modules. Provide printouts to document that all fiber optic strands meet specified criteria before installation.

3.3.2.2. After cable placement, perform a second OTDR test to verify the cable was not damaged during installation; also verify distances of cable runs and system integrity. Enter all results into the system documentation.

3.3.2.3. After strands are terminated, perform an OTDR end-to-end test from each end to prove the terminations. Enter all results into the system documentation.

3.3.2.4. Single mode fiber will be tested at 1310 nm and 1550 nm. Multi-mode fiber will be tested at 850 nm and 1300 nm.

3.3.3. Performance Specifications:

3.3.3.1. All fiber shall be SX laser optimized. SX laser optimized cable shall meet the following minimum specifications:

Maximum Attenuation:
<=2.4 dB at 850 nm
<=0.7 dB at 1300 nm

Single Mode Specification:
1.0 dB at 1310 nm
1.0 dB at 1550 nm

Minimum Bandwidth:
200 MHz.km at 850 nm

500 MHz.km at 1300 nm

Glass Geometry	
Core Diameter	50.0 =/- 2.5um
Cladding Diameter	125.0 =/- 2.0um
Core-Clad Concentricity	<= 1.5um
Cladding Non-Circularity	<= 1.0%
Core Non-circularity	<= 5%

3.3.3.2. Copper Riser Cable Testing:

3.3.3.2.1. Riser Cable Testing:

3.3.3.2.1.1. End –To-End Polarity Testing: A minimum of 99% pair functional connectivity shall be verified by end-to-end polarity testing. Polarity test shall verify correct tip, ring and pair.

3.3.3.2.1.2. TDR Test: Perform a Time Domain Reflectivity test to verify splices and correct gauge of wire throughout the run.

3.3.3.2.1.3. Documentation: Provide complete documentation of each test performed and printout of TDR test.

3.3.3.2.1.4. Contractor shall submit each test to AMP-400 for acceptance and approval by the FAA. AMP-400 shall provide test results to AMK-224 for review and approval. Contractor shall replace any defective or noncompliant cable at no additional cost to the FAA.

3.4. PROTECTION OF SYSTEMS AND EQUIPMENT

3.4.1.1. Asbestos Survey: Prior to the disturbance of any building materials, construction personnel must know the results of an asbestos survey.

3.4.1.2. Lead Survey: Prior to the disturbance of any building materials, construction personnel must know the results of a lead survey.

3.4.1.3. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

3.4.1.4. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.

3.4.1.5. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.

3.4.1.6. As determined by AMK-224, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the documentation provided. Decisions of AMK-224 shall be final.

3.4.1.7. Painted surfaces shall be protected with removable heavy Kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by the manufacturer.

3.5. WORK PERFORMANCE

3.5.1. Coordinate location of equipment and conduit with other trades to minimize interference.

3.5.2. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drill shall not be allowed, except where permitted by the AMP-400 Project Manager as required by limited working space.

3.5.2.1. Holes shall be located so as not to affect structural sections such as ribs or beams.

3.5.2.2. Holes shall be laid out in advance. The AMP-400 Project Manager shall be advised prior to drilling through structural sections, for determination of proper layout.

3.5.2.3. Structural Penetrations: Where conduit, wire ways and other raceways pass through fire partitions, fire walls or walls and floors, provide FAA approved effective barrier against the spread of fire, smoke and gases.

3.6. ACCESS TO EQUIPMENT

3.6.1. Equipment shall be installed in location and manner that will allow convenient access for maintenance and inspection.

3.6.2. Working spaces shall not be less than specified in the National Electrical Code for voltages specified.

3.6.3. Where the AMP-400 Project Manager determines that the telecommunications subcontractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the AMP-400 Project Manager, at no additional cost to the FAA. "Conveniently accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.7. CABLE TERMINATION AND DRESS

3.7.1. Installation of signal, video, and communication and control conductors shall adhere to the following:

3.7.2. Cables shall be dressed, labeled and hook & loop wrap in cabinets, racks and/or at cross connect backboard to present a neat, logical and orderly installation. At the discretion of the telecommunications subcontractor, cable duct with removable covers may be installed in equipment cabinets and control consoles to facilitate satisfying this requirement.

3.7.3. Cables shall be secured to equipment cabinet backboards, console members or to other system components using cable clamps and hook & loop wraps. The telecommunications subcontractor shall furnish and install cable support posts to facilitate system installation.

3.7.4. Cables and conductors shall be terminated with cable termination connectors compatible with the specific termination.

3.7.5. Metallic cables and conductors entering the facility from a point exterior to the building shall be equipped with lightning protection. Protector shall be located at the nearest point of cable entry in the building.

3.8. UPS POWER

3.8.1. All electrical circuits supplying power to system components as part of telecommunications work shall be connected to existing UPS power. If UPS is not available, advise AMP-400 to contact AMK-224 at (405) 954-3651.

3.9. CLEANING

3.9.1. During construction, and prior to FAA acceptance of the building, remove from the premises and dispose of packing material and debris caused by telecommunications work.

3.9.2. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.10. COMPLETION

3.10.1. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

3.10.2. Systems shall be complete and operational, and controls shall be set and calibrated.

3.10.3. Testing, start-up, and cleaning work shall be complete.

3.10.4. Special tools for proper operation and maintenance of equipment provided under this specification shall be delivered to the FAA.

3.10.5. All punch list items must be corrected prior to acceptance of project.

3.11. TESTING AND VERIFICATION

3.11.1. The telecommunications subcontractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.

3.11.2. Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the FAA.

3.11.3. Verification by Test and Demonstration: The telecommunications subcontractor shall verify by formal demonstrations or tests that the requirements of this specification have been met. The telecommunications subcontractor shall demonstrate that the telecommunications systems components and subsystems meet specification requirements in the “as-installed” operating environment during the “System Operation Test.” While no formal environmental testing is required, the telecommunications subcontractor shall measure and record temperature, humidity

and other environmental parameters and the environmental conditions, which were encountered during the "System Operation Test."

3.11.4. Perform commissioning and pretest prior to enclosure of walls.

3.11.5. Perform system operation tests after full enclosure of walls.

3.11.6. System Operation Tests Conducted Upon Completion Of Work: Upon completion of the telecommunications subcontractor's work, subject the system to functional and operational tests. When required, corrections determined by initial test results, have been completed, fully retest the system. The FAA shall be notified in writing not less than seven days in advance of the date of proposed final testing and inspection. The advance notice shall include certification that the installation is complete and operable, and that the telecommunications subcontractor has satisfactorily performed the final tests specified herein. The acceptance testing and final inspection shall be accomplished in the presence of the FAA and the AMP-400 Project Manager. At least ten days prior to scheduled system completion, the telecommunications subcontractor shall submit, for approval by the FAA a test plan to completely test telecommunications systems. The telecommunications subcontractor shall include in test plan, for acceptance by the FAA (AMK-224 and the AMP-400 Project Manager), a complete and detailed final acceptance test check-off list ("punch list). The list shall be a complete representation of specified functions and conditions, including contingency, priority and abnormal modes of operation. The arrangements of the list shall be such as to provide an orderly method of tabulating checks of system features, response and operation. The punch list shall include a designated space adjacent to each test procedure where the FAA can initial to indicate compliance with each test procedure. At the time of final acceptance testing, required tests shall be repeated and defects corrected until the system is found to be acceptable to AMK-224 and AMP. The telecommunications subcontractor shall maintain a log of test activities and results. Both electronic and printed copies of this log including copies of the signed-off punch list shall be submitted to the FAA within seven days of the testing. Final tests shall include, but not limited to, the following:

3.11.7. Test all category cables in accordance with current TIA/EIA specifications for that category of cabling with a test device meeting or exceeding level IIe accuracy.

3.11.8. Bi-directional attenuation (loss) test for each multimode fiber strand at 850nm and 1300nm wavelengths and each single mode fiber strand at 1310nm and 1550nm. Conduct tests in accordance with ANSI/TIA/EIA-526-14-A, Method B for multimode fibers, and ANSI/TIA/EIA-526-7, Method A.1 for single mode fibers and with test instrument manufacturers printed instructions. Demonstrate that measured link loss does not exceed the "worst case" allowable loss which is the sum of: the connectors loss (based on the number of mated connector pairs at the ANSI/TIA/EIA-568-A maximum allowable loss of 0.75dB per

mated pair) and the optical fiber loss (based on the maximum allowable loss of 3.5 dB/km @ 850nm and 1.5 dB/km @ 1300nm for multimode fiber and 1.0 dB/km @ 1310nm and 1.0 dB/km @ 1550nm for indoor single mode fiber and 0.5 dB/km @ 1310nm and 0.5 dB/km @ 1550nm for outdoor single mode fiber).

3.11.9. Visual inspection of cabling for proper routing bends radii cable management and security.

3.11.10. Verification that required submittals have been provided and have been accepted.

3.11.11. The telecommunications subcontractor shall carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. The telecommunications subcontractor shall provide necessary instruments, labor and materials required for tests, including the equipment manufacturer's technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period. The AMP-400 and AMK-224 office reserve the right to be present during testing.

3.11.12. After telecommunications systems have been installed and tested, the completed test plan shall be signed by the telecommunications subcontractor and submitted for approval.

4. TELECOMMUNICATIONS JACK LABELING STANDARD

4.1.1. Abstract:

4.1.1.1. This standards statement documents the practice for labeling telecommunications jacks during the installation process. Telecommunications jacks shall be installed in accordance with the Telecommunications Jack Cabling Standard. This standard requires that a unique position number be designated for each telecommunications jack. Additionally, this standard requires that the telephone closet that hosts the telecommunications jack will be identified in the position number of the telecommunications jack.

4.1.2. Standard:

4.1.2.1. The labeling standards define the labeling at the jack location as well as in the telephone closet. In all cases the labels at the jack and in the closet will be made with high contrast permanent material, which may be removed and replaced in the field.

4.1.3. At The Jack:

4.1.3.1. This standard defines a position as a location housing jacks whether it is a "tombstone," surface plug, power pole or a "Walker" box. A jack is the wiring device installed in a position, which allows for connection of the telecommunications device. The labeling number will be six characters in the format of:

CCCPPP

4.1.3.2. The syntax of the label is:

<Closet Number><Position Number>

4.1.4. At The Closet:

4.1.4.1. This standard defines the nomenclature as a location designated on a designation strip on a Patch Panel. The labeling number will be seven characters in the format of:

CCCPPPF

4.1.4.2. The syntax of the label is:

><Closet Number><Position Number><Duplication Flag>

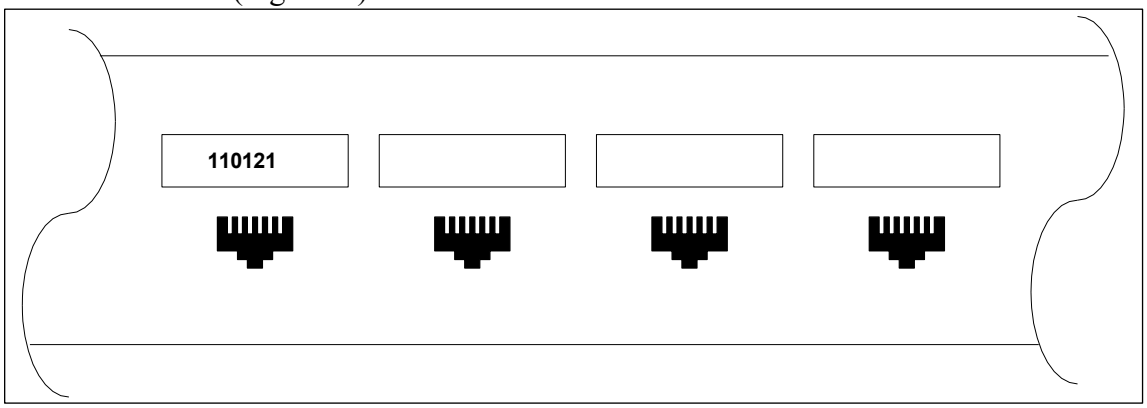
Further Definitions:

Labeling Syntax	Permitted Character	Permitted Value	Description
Closet Room Number	Alpha/Numeric	001-999 A-Z *	The room number of the serving closet as it will be labeled at contract completion. * (In cases where the closet number is larger than 3 characters, the closet number shall be trimmed to the useful three digits as determined by AMK-224, i.e. BC04G>C04 127B>127
Sequence Number	Numeric	001-999	This is a unique number for the position, which usually is the sequence number of when the jack was installed.
Duplication Flag	Alpha	A-D	If the descriptive is duplicated in an installation (i.e. multiple analog numbers at the same position.)

4.1.5. Example In Closet:

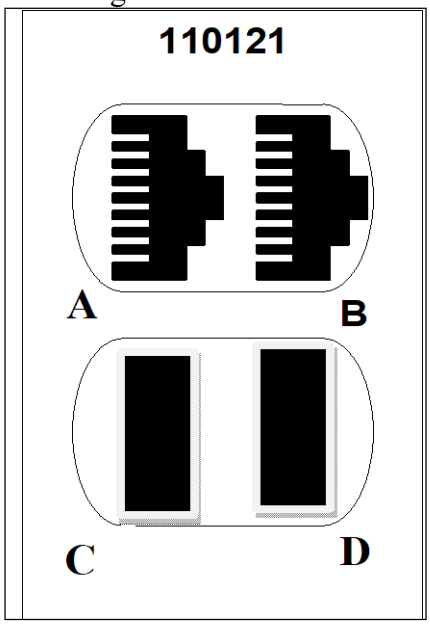
4.1.5.1. LAN and analog circuits are installed to work out of closet 110. This is the 121st position installed in this closet. The jack number would be: 110121
(With the analog number posted by the jack when activated by a telephone work order.)

4.1.5.2. In the closet, the LAN jack would be labeled on the supporting Patch Panel as 110121 (Figure A).



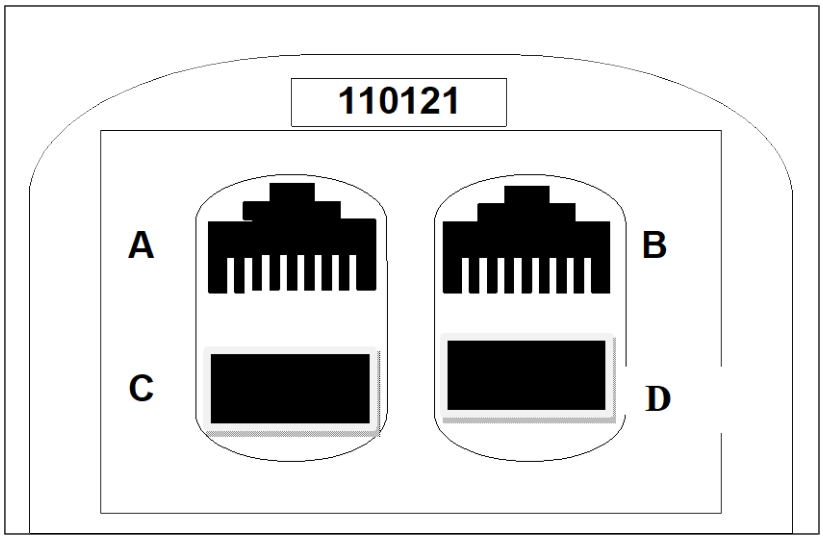
Patch Panel Detail A
Figure A

4.1.5.3. Jack number is centered at the top of the jack. At the position with the jacks, on a quad plate, the upper two jack positions are LAN jacks with orange jacks. Lower two jack positions are blank for future requirements. If it is an analog line, the analog number will be indicated on the jack when an analog telecommunications work order is complete (Figure B).

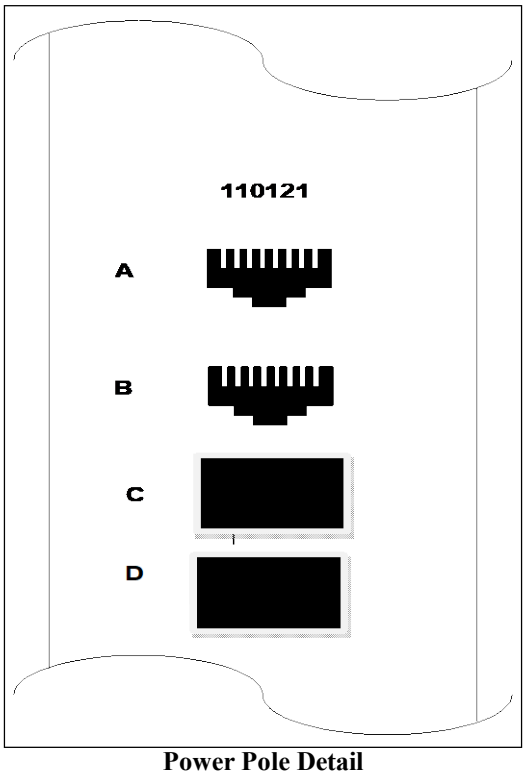


Quad Detail **Figure B**

4.1.5.4. Figure C (Tombstone Detail) and Figure D (Power Pole Detail) below, extend the jack labeling to the "Tombstone" and "Power Pole" configuration. The "Walker Box" will use the "Quad" (Figure B) jack layout. Other configurations may be approved by AMK-224.



Tombstone Detail
Figure C

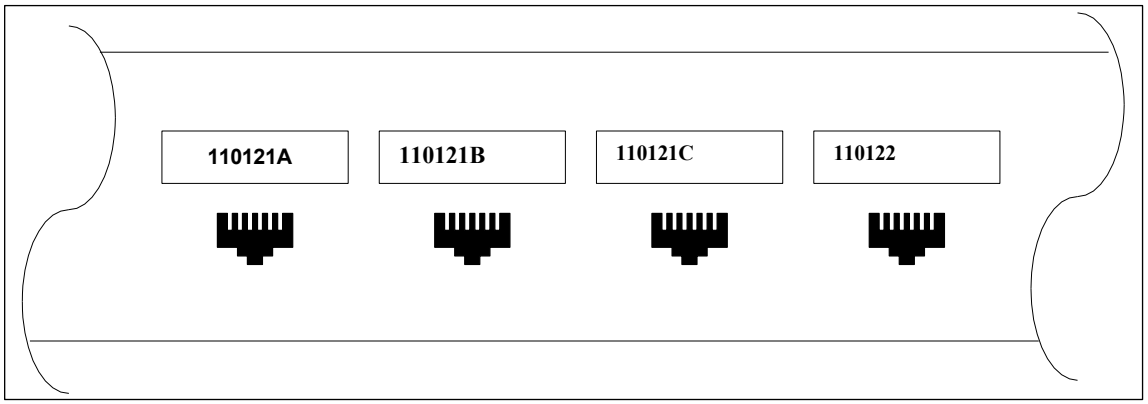


Power Pole Detail
Figure D

4.1.6. Situation 2:

4.1.6.1. A new work order is issued for an additional LAN connection at the position installed in Situation 2. Its jack number would be L110121B (C, D, E, etc.). Re-label previous LAN connection from L to L-A.

4.1.6.2. In the closet, the old jack on the Patch Panel is re-designated as 110121A. The second LAN jack is terminated in an open position on the Patch Panel and designated 110121B (Figure E)



Patch Panel Detail B
Figure E

4.1.7. Exceptions To Standard:

4.1.7.1. Every effort should be made to adhere to these standards for all new installations. When new wiring is pulled to an existing position labeled in the old style, the position and wiring may reflect the legacy and pre-existing style. New positions with new jacks shall adhere to the new labeling standard at the position.

4.1.8. References:

Item	Description
Telecommunications Jack Cabling Standards	Standards describing what material are required and how to wire telecommunications jacks.

5. TELECOMMUNICATIONS JACK CABLING STANDARD

5.1.1. ABSTRACT:

5.1.1.1. This standards statement documents the material and practice for installing telecommunications jacks from a designated telephone closet to a designated telecommunications jack location which may be installed in a "Walker" Box, "Tombstone", Cubicle, Wall, or Surface mounted apparatus. FAA data and voice cabling shall maintain separation from any other cabling not on the MMAC backbone. Cable shall not be run in the same conduit as non-MMAC backbone cable. FAA MMAC backbone positions shall include only FAA MMAC data and voice. Cables must be labeled behind faceplate in accordance with labeling standard. Requirements for non-FAA MMAC backbone data shall require a separate position. For further information or any questions contact AMK-224 at (405) 954-3651.

5.1.2. STANDARD:

5.1.2.1. In accordance with EIA/TIA 568 and 569 series the primary method of meeting communications needs will be the installation of 4 pair Category 6 or better wiring (Berk-Tek is the current specification) as required. Generally, run one 4 pair wire for each LAN jack to the closest Telecommunications Closet. See Table I below for wire termination to jack pins.

5.1.2.2. The current jack materials will also be rated for Category 6 or better.

5.1.3. EXCEPTIONS TO STANDARDS:

5.1.3.1. In the building spaces not yet renovated at the Aeronautical Center, ducts and conduits may not be sufficient to support this standard. In those cases, AMK-224 will provide wiring guidance as necessary.

5.1.4. REFERENCES:

EIA/TIA 568-A	Commercial Building Telecommunications Wiring Standard.
EIA/TIA-569	Commercial Building Standard for Telecommunications Pathway and Spaces
EIA/TIA-606	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

TSB 36	Technical Systems Bulletin-Additional Cable Specifications for Unshielded Twisted Pair Cables
TSB 40	Technical Systems Bulletin-Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware
IEEE 802.3	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

6. COPPER/FIBER SPLICING STANDARD

This document constitutes the copper and fiber cable-splicing standard for the Mike Monroney Aeronautical Center (MMAC).

6.1.1. SCOPE

6.1.1.1. This standard describes approved methods for splicing plastic insulated copper and fiber optic cables. Typical applications of these methods include aerial, buried and underground splices.

6.1.1.2. Copies of the American National Standard Institute/National Fire Protection Association (ANSI/NFPA) 70, National Electrical Code (NEC), referenced in this standard, can be obtained from NFPA, Batterymarch Park, Quincy, Massachusetts 02269, at telephone number 1 (800) 344-3555.

6.1.1.3. Copies of the American National Standard Institute/Institute of Electrical and Electronics Engineers, Inc. (ANSI/IEEE), National Electrical Safety Code (NESC), referenced in this standard, can be obtained from IEEE Service Center, 455 Hoes Lane, Piscataway, New Jersey 08854, telephone number 1 (800) 678-4333.

6.1.1.4. Copies of the Rural Utilities Services (RUS) standards and forms can be obtained from Mr. Charlie Harper at the Rural Utilities Service of the United States Department of Agriculture. Mr. Harper may be contacted at (202) 720-0667 (telephone), (202) 760-4099 (Fax) or by electronic mail at charper@rus.usda.gov.

6.1.2. GENERAL

6.1.2.1. Only Federal Aviation Administration (FAA) accepted filled cable and splicing materials are to be used on outside plant projects on FAA property.

6.1.2.2. The installation instructions provided by the manufacturer of splicing materials shall be followed except where those instructions conflict with the procedures specified in this standard.

6.1.2.3. Precautions shall be taken to prevent the ingress of moisture and other contaminants during all phases of the splicing installation. When an uncompleted splice must be left unattended, it shall be sealed to prevent the ingress of moisture and other contaminants.

6.1.2.4. Minor sheath damage during construction may be repaired if the repair is completed immediately and is approved by the FAA representative. Minor damage is typically repaired by:

6.1.2.4.1. Scuffing the cable sheath associated with the damaged area.

6.1.2.4.2. Applying several layers of DR tape over the scuffed and damaged area.

6.1.2.4.3. Applying several layers of plastic tape over the DR tape; and

6.1.2.4.4. If damage is severe enough to rupture the cable shield, a splice closure shall be installed.

6.1.2.5. All splice cases installed on all FAA outside plant cables shall be filled, whether aerial, buried, or underground.

6.1.3. SPLICING CONSIDERATION FOR COPPER CABLES

6.1.3.1. Pre-construction Testing: It is desirable that each reel of cable be tested for grounds, opens, shorts, crosses, and shield continuity before the cable is installed. However, manufacturer supplied test results are acceptable. All cable pairs shall be free from electrical defects.

6.1.3.2. Handling Precautions: The cable manufacturers' instructions concerning pulling tension and bending radius shall be observed. Unless the cable manufacturer's recommendation is more stringent, the minimum-bending radius shall be ten times the cable diameter for copper cables and twenty times the cable diameter for fiber optic cables.

6.1.3.3. Cable Sheath Removal:

6.1.3.3.1. The length of cable sheath to be removed shall be governed by the type of splicing hardware used. Follow the splice case manufacturer's recommendations. For pedestals or large pair count splice housings, consider removing enough cable sheath to allow the conductors to extend to the top of the pedestal and then hang downward to approximately 15 centimeters (cm) (6 inches (in.)) above the base plate.

6.1.3.3.2. Caution shall be exercised to avoid damaging the conductor insulation when cutting through the cable shield and removing the shield. Sharp edges and burrs shall be removed from the cut end of the shield.

6.1.4. SHIELD BONDING AND GROUNDING:

6.1.4.1. For personnel safety, the shields of the cables to be spliced shall be bonded together and grounded before splicing activities are started.

6.1.5. BINDER GROUP IDENTIFICATION:

6.1.5.1. Color-coded plastic tie wraps shall be placed loosely around each binder group of the cables before splicing operations are attempted. The tie wraps shall be installed as near the cable sheath as practicable and shall conform to the same color designations as the binder ribbons. Twisted wire pigtails shall not be used to identify binder groups due to potential transmission degradation.

6.1.5.2. The standard insulation color code used to identify individual cable pairs within 25-pair binder groups shall be as shown in Table I:

TABLE I
Cable Pair Identification Within Binder Groups

Pair #	Tip	Ring
1	White	Blue
2	White	Orange
3	White	Green
4	White	Brown
5	White	Slate
6	Red	Blue
7	Red	Orange

8	Red	Green
9	Red	Brown
10	Red	Slate
11	Black	Blue
12	Black	Orange
13	Black	Green
14	Black	Brown
15	Black	Slate
16	Yellow	Blue
17	Yellow	Orange
18	Yellow	Green
19	Yellow	Brown
20	Yellow	Slate
21	Violet	Blue
22	Violet	Orange
23	Violet	Green
24	Violet	Brown
25	Violet	Slate

6.1.5.3. The standard binder ribbon color code used to designate 25-pair binder groups within 600-pair super units shall be as shown in Table II:

TABLE II

Group #	Color of Bindings		Group Pair Count
1	White	Blue	1-25
2	White	Orange	26-50
3	White	Green	51-75
4	White	Brown	76-100
5	White	Slate	101-125
6	Red	Blue	126-150
7	Red	Orange	151-175
8	Red	Green	176-200
9	Red	Brown	201-225
10	Red	Slate	226-250
11	Black	Blue	251-275
12	Black	Orange	276-300
13	Black	Green	301-325
14	Black	Brown	326-350
15	Black	Slate	351-375
16	Yellow	Blue	376-400
17	Yellow	Orange	401-425
18	Yellow	Green	426-450
19	Yellow	Brown	451-475
20	Yellow	Slate	476-500
21	Violet	Blue	501-525
22	Violet	Orange	526-550
23	Violet	Green	551-575
24	Violet	Brown	576-600

6.1.5.4. Super-unit binder groups shall be identified in accordance with Table III:

TABLE III
Super-Unit Binder Colors

Pair Numbers	Binder Colors
1-600	White
601-1200	Red
1201-1800	Black
1801-2400	Yellow
2401-3000	Violet
3001-3600	Blue
3601-4200	Orange
4201-4800	Green
4801-5400	Brown
5401-6000	Slate

6.1.5.5. Service pairs in screened cables shall be identified in accordance with Table IV:

TABLE IV
Screened Cable Service Pair Identification

Service Pair #	Tip	Ring
1	White	Red
2	White	Black
3	White	Yellow
4	White	Violet
5	Red	Black
6	Red	Yellow
7	Red	Violet
8	Black	Yellow
9	Black	Violet

6.1.6. CLEANING CONDUCTORS:

6.1.6.1. It is not necessary to remove the filling compound from cable conductors before splicing. However, it is permissible to wipe individual conductors with clean paper towels or clean cloth rags. No cleaning chemicals, etc. shall be used. Caution shall be exercised to maintain individual cable pair and binder group identity. Binder group identity shall be maintained by using color-coded plastic tie wraps. Individual pair identification shall be maintained by carefully twisting together the two conductors of each pair.

6.1.7. EXPANDED PLASTIC INSULATED CONDUCTOR (PIC) PRECAUTIONS:

6.1.7.1. Solid PIC and expanded (foam or foam skin) PIC are spliced in the same manner, using the same tools and materials and, in general, should be treated the same. However, the insulation on expanded PIC is much more fragile than solid PIC. Twisting or forming expanded PIC into extremely compact splice bundles and applying excessive amounts of tension when tightening tie wraps causes shiners and thus shall be avoided.

6.1.8. SPLICE CONNECTORS:

6.1.8.1. Only FAA accepted filled splice connectors shall be used on outside plant projects.

6.1.8.2. Specialized connectors are available for splicing operations such as butt splices, in-line splices, bridge taps, clearing and capping, and multiple pair splicing operations. The splice connector manufacturer's recommendations shall be followed concerning connector selection and use.

6.1.8.3. Caution shall be exercised to maintain conductor and pair association both during and after splicing operations.

6.1.8.4. Splicing operations that involve pairs containing working services shall utilize splice connectors that permit splicing without the interruption of service.

6.1.9. PIECING OUT CONDUCTORS:

6.1.9.1. Conductors may be pieced-out to provide additional slack or to repair damaged conductors. However, the conductors shall be pieced-out with conductors having the same gauge and type and color of insulation. The conductors used for piecing-out shall be from cables having FAA acceptance.

6.1.10. SPLICE ORGANIZATION:

6.1.10.1. Spliced pair bundles shall be arranged in firm lay-ups with minimum conductor tension in accordance with the hardware manufacturer's instructions.

6.1.11. BINDER TAPE:

6.1.11.1. Perforated non-hygroscopic and non-wicking binder tape should be applied to splices housed in filled splice cases. The binder tape allows the flow of filling compound, while holding the splice bundles near the center of the splice case, to allow adequate coverage of filling compound.

6.1.12. CABLE TAGS:

6.1.12.1. A tag indicating the cable manufacturer's name, cable size, date of placement, and generic route information shall identify Cables. Information susceptible to changes caused by future cable throws and rearrangements should not be included. Tags on load coil stubs shall include the serial number of the coil case, the manufacturer's name, and the inductance value.

6.1.13. SCREENED CABLE:

6.1.13.1. Screened PIC cable is spliced in the same manner as non-screened PIC cable. However, special considerations are necessary due to differences in the cable design. The transmit and receive bundles of the cable shall be separated and one of the bundles shall be wrapped with shielding material in accordance with the cable manufacturer's recommendations. When acceptable to the cable manufacturer, it is permissible to use either the scrap screening tape removed from the cable during the sheath opening process provided the screening tape is edge coated or new pressure sensitive aluminum foil tape over polyethylene tape.

6.1.14. SERVICE WIRE CONNECTIONS:

6.1.14.1. Buried service wires may be spliced directly to cable conductors inside pedestals using the same techniques required for branch cables. Buried service wires may also be terminated on terminal blocks inside pedestals in areas where high service order activity or fixed count cable administration policies require terminal blocks. However, only FAA accepted terminal block equipped with grease or gel filled terminations to provide moisture and corrosion resistance shall be used.

6.1.15. COPPER CABLE TESTING:

6.1.15.1. Copper cable testing shall be performed in accordance with Bulletin 7CFR1755.403 Copper Cable Telecommunications Plant Measurements.

6.1.16. CABLE ACCEPTANCE:

6.1.16.1. Installed cable shall be tested and pass the inventory and acceptance testing specified in the Telephone System Construction Contract (Labor and Materials), RUS Form 515. The tests and inspections shall be witnessed by the borrower's resident project representative. All conductors shall be free from grounds, shorts, crosses, splits and opens.

6.1.17. SPLICE ARRANGEMENTS FOR COPPER CABLES:

6.1.17.1. Service Distribution Closures:

6.1.17.1.1. Ready access closures permit cable splicing activities and the installation of filled terminal blocks for service wire connections in the same closure. Ready access designs shall allow service technicians direct access to the cable core as well as the terminal block.

6.1.17.1.2. Fixed count terminals shall restrict service technician access to the cable core. Predetermined cable pairs shall be spliced to the terminal leads or stub cable in advance of service assignments.

6.1.18. LARGE PAIR COUNT SPLICE HOUSINGS:

6.1.18.1. Large pair count splice housings are recommended for areas not suitable for manholes. The recommended capacities are shown in Table VI:

TABLE VI
Splice Capacities for Large Pair Count Housings

Housing Type	Maximum Straight Splice Pair Capacity Using Single Pair Connectors or Multiple Pair Splice Modules	Maximum Load Splice Pair Capacity Unit Single Pair Connectors or Multiple Pair Splice Modules
BD6000	6,000 Pair	3,000 Pair
BD8000	8,000 Pair	4,000 Pair
BD10000	10,000 Pair	5,000 Pair

6.1.19. PEDESTAL RESTRICTED ACCESS INSERTS:

6.1.19.1. Restricted access inserts may be used to protect splices susceptible to unnecessary handling where subsequent work activities are required or expected to occur after splices have been completed. Restricted access inserts also provide moisture protection in areas susceptible to temporary flooding.

6.1.20. SERVING AREA INTERFACE (SAI) SYSTEMS:

6.1.20.1. SAI systems provide the cross-connect point between feeder and distribution cables. Connection of feeder to distribution pairs is accomplished by placing jumpers between connecting blocks. Only FAA accepted connecting blocks having grease or gel filled terminations to provide moisture and corrosion resistance shall be used.

6.1.21. UNDERGROUND SPLICES (MANHOLES):

6.1.21.1. Underground splice cases accommodate straight splices, branch splices, and load coils. Underground splices shall be filled.

6.1.22. CENTRAL OFFICE TIP CABLE SPLICES:

Filled cable or filled splices are not recommended for use in central offices, except in cable vault locations. Outside plant cable sheath and cable filling compound are susceptible to fire and will support combustion. Fire, smoke and gases generated by these materials during burning are detrimental to telephone switching equipment.

6.1.22.1. Tip cables should be spliced in a cable vault. However, as a last resort, tip cables may be spliced inside a central office if flame retardant splice cases or noncombustible central office splice housing is used to contain the splice.

6.1.22.2. Splices inside the central office shall be made as close as practical to the point where the outside plant cables enter the building. Except in cable vault locations, outside plant cables within the central office shall be wrapped with fireproof tape or enclosed in noncombustible conduit.

6.1.23. HANDLING PRECAUTIONS:

The following precautions shall be observed:

6.1.23.1. Avoid damaging the cable during handling operations prior to splicing. Apparent minor damage may change the transmission characteristics of the fibers to the extent that the cable section will have to be replaced.

6.1.23.2. The cable manufacturer's recommendations concerning pulling tension shall be observed. The maximum pulling tension for most fiber optic cable is 2669 Newton's (600 pound-force).

6.1.23.3. The cable manufacturer's recommendations concerning bending radius shall be observed. Unless the cable manufacturer's recommendation is more stringent, the minimum-bending radius for fiber optic cable shall be twenty times the cable diameter.

6.1.23.4. The cable manufacturer's recommendations concerning buffer tube bending radius shall be observed. Unless the cable manufacturer's recommendation is more stringent, the minimum-bending radius for buffer tubes is usually between 38 millimeters (mm) (1.5 inches) and 76 mm (3.0 inches). The bending limitations on buffer tubes are intended to prevent kinking. Buffer tube kinking may cause excessive optical loss of fiber breakage.

6.1.23.5. Handle unprotected glass fibers carefully to avoid introducing flaws such as scratched or broken fibers.

6.1.24. PERSONNEL SAFETY:

The following safety precautions shall be observed:

6.1.24.1. Safety glasses shall be worn when handling glass fibers.

6.1.24.2. Never view open-ended fibers with the naked eye or a magnifying device. Improper viewing of a fiber end that is transmitting light may cause irreparable eye damage.

6.1.24.3. Dispose of bare scrap fibers by using the sticky side of a piece of tape to pick up and discard loose fiber ends. Fiber scraps easily penetrate the skin and are difficult to remove.

6.1.25. EQUIPMENT REQUIREMENTS:

6.1.25.1. Fiber optic splices shall be made in areas where temperature, humidity, and cleanliness can be controlled. Fusion splicing techniques may require a splicing vehicle equipped with a workstation that will allow environmental control.

6.1.25.2. Only fusion splicing techniques are permitted on FAA projects.

6.1.25.3. Fusion splicing machines shall be kept in proper working condition. Regular maintenance in accordance with the machine manufacturer's recommendations shall be observed.

6.1.25.4. An optical time domain refractometer (OTDR) shall be used for testing splices. The OTDR shall be stationed at the central office or launch point for testing individual splices as they are made and for end-to-end signature tests for the fiber optic link.

6.1.26. CABLE PREPARATION:

6.1.26.1. The required slack is 15 meters (50 feet). The amount of slack used shall be recorded for each splice point to assist future maintenance and restoration efforts.

6.1.27. SHIELD BONDING AND GROUNDING:

6.1.27.1. For personnel safety, the shields and metallic strength members of the cables to be spliced shall be bonded together and grounded before splicing activities are started.

6.1.28. FIBER OPTIC COLOR CODE:

6.1.28.1.1. The standard fiber optic color code for buffer tubes and individual fibers shall be as shown in Table VII.

TABLE VII
Fiber & Buffer Tube Identification

Buffer & Fiber Number	Color
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Rose
12	Aqua
13	Blue/Black Tracer
14	Orange/Black Tracer
15	Green/Black Tracer
16	Brown/Black Tracer
17	Slate/Black Tracer
18	White/Black Tracer
19	Red/Black Tracer
20	Black/Yellow Tracer
21	Yellow/Black Tracer
22	Violet/Black Tracer
23	Rose/Black Tracer
24	Aqua/Black Tracer

6.1.29. COMPLETION OF THE SPLICE:

6.1.29.1. The splice shall be completed by fusing the splice.

6.1.29.2. Each spliced fiber shall be routed through the organizer tray one at a time as splices are completed. The fibers shall be organized one at a time to prevent tangled spliced fibers. The splice case manufacturer's recommendation shall be followed concerning the splice tray selection.

6.1.30. FIBER OPTIC TESTING:

6.1.30.1. Fiber optic testing shall be performed in accordance with Division 27 standard for acceptance tests and measurements of telephone plant.

6.1.31. CABLE ACCEPTANCE:

6.1.31.1. Installed cable shall be tested and pass the inventory and acceptance testing specified in Division 27. The tests and inspections shall be witnessed by the contractor's resident project representative.

6.1.32. SPLICE ARRANGEMENTS FOR FIBER OPTIC CABLES:

6.1.32.1. Underground Manhole Splices: Underground splices shall be stored in manholes on cable hooks and racks fastened to the manhole wall.

6.1.32.2. Central Office Cable Entrance:

6.1.32.2.1. Filled cable or filled splices are not recommended for use inside the central offices except in cable vault locations. Outside plant cable sheath and cable filling compound are susceptible to fire and will support combustion. Fire, smoke and gases generated by these materials during burning are detrimental to telephone switching equipment.

6.1.32.2.2. Splices inside the central office shall be made as close as practicable to the point where the outside plant cables enter the building. Except in cable vault locations, outside plant cables within the central office shall be wrapped with fireproof tape or enclosed in noncombustible conduit.

6.1.33. BONDING AND GROUNDING FIBER OPTIC CABLE, COPPER CABLE, AND COPPER SERVICE WIRE:

6.1.33.1. Bonding: Bonding is electrically connecting two or more metallic items of telephone hardware to maintain a common electrical potential. Bonding may involve connections to another utility.

6.1.33.2. Copper Cable Shield Bond Connections:

6.1.33.2.1. Cable shields shall be bonded at each splice location. Only FAA accepted cable shield bond connectors shall be used to provide bonding and grounding connections to metallic cable shields. The shield bond connector manufacturer's instructions shall be followed concerning installation and use.

6.1.33.2.2. Shield bonding conductors shall be either stranded or braided tinned copper wire equivalent to a minimum Number 6 American Wire Gauge (AWG) and shall be FAA accepted. The conductor connections shall be tinned or of a compatible bimetallic design to avoid corrosion problems associated with dissimilar metals. The number of shield bond connectors required per pair size and gauge shall be as shown in Table VIII.

TABLE VIII

Shield Bond Connectors Per Pair Size & Gauge

19 AWG	22 AWG	24 AWG	26 AWG	# Of Shield Bond Connectors
0-25	0-100	0-150	0-200	1
50-100	150-300	200-400	300-600	2
150-200	400-600	600-900	900-1500	3
300-600	900-1200	1200-2100	1800-3600	4

6.1.33.2.3. It is permissible to strap across the shield bond connectors of several cables with a single length of braided wire. However, both ends of the braid shall be terminated on the pedestal ground bracket to provide a bonding loop.

6.1.33.3. Fiber Optic Cable Bond Connections:

6.1.33.3.1. The cable shield and metallic strength members shall be bonded at each splice location. Only FAA accepted fiber optic cable shield bond connectors shall be used to

provide bonding connections to the metallic cable shields. The shield bond connector manufacturer's instructions shall be followed concerning installation and use.

6.1.33.3.2. Shield bonding conductors shall be either stranded or braided tinned copper wire equivalent to a minimum Number 6 AWG and shall be FAA accepted. The conductor connections shall be tinned or of a compatible bimetallic design to avoid corrosion problems associated with dissimilar metals.

6.1.33.4. Grounding:

6.1.33.4.1. Grounding is electrically connecting metallic telephone hardware to a National Electrical Safety Code (NESC) acceptable grounding electrode. Acceptable grounding electrodes are defined in the Rule 99A of the NESC.

6.1.33.4.2. The conductor used for grounding metallic telephone hardware shall be a minimum Number 6 AWG solid, bare copper conductor.

6.1.33.4.3. For copper and fiber optic cable plant, all cable shields, all metallic strength members, and all metallic hardware shall be:

6.1.33.4.3.1. Grounded at each splice location to a driven grounding electrode (ground rod) of:

6.1.33.4.3.2. At least 1.5 meters (5 feet) in length where the local frost level is normally less than 0.30 meters (1 foot) deep; or

6.1.33.4.3.3. At least 2.44 meters (8 feet) in length where the local frost level is normally 0.30 meters (1 foot) or deeper;

6.1.33.4.3.4. Bonded to a multi-grounded power system neutral when the splice is within 1.8 meters (6 feet) of access to the grounding system of the multi-grounded neutral system. Bonding to the multi-grounded neutral of a parallel power line may help to minimize telephone interference on long exposures with copper cable plant. Consideration, thus, should be given to completing such bonds, at least four (4) times each mile, when splices are greater than 1.8 meters (6 feet) but less than 4.6 meters (15 feet) from access to the multi-grounded neutral.

6.1.33.5. Bonding and Grounding Splice Cases:

6.1.33.5.1. Splice cases are equipped with bonding and grounding devices to ensure the cable shields and metallic strength members maintain electrical continuity during and after cable splicing operations. The splice case manufacturer's recommendations shall be followed concerning the bonding and grounding procedures. Conductors used for bonding shall be either stranded or braided tinned copper wire equivalent to 6 AWG. Conductors used for grounding shall be a solid, bare, copper wire equivalent to minimum Number 6 AWG.

6.1.33.5.2. Bonding and Grounding Central Office Cable Entrances:

6.1.33.5.2.1. The RUS Telecommunications Engineering and Construction Manual (TE&CM) Section 810 provides bonding and grounding guidance for central office cable entrances. Splicing operations shall not be attempted before all metallic cable shield and strength members are bonded and grounded.

7. MMAC COMMUNICATIONS GENERAL SPECIFICATIONS

7.1. The building shall have one or two types of communications closets. The two types of closets are "telecommunications closet" and telecommunications master closet." The building shall have one and only one telecommunications master closet. Based on the criteria contained herein, the building shall have as many telecommunications closets as are required to provide telephone and Local Area Network (LAN) service to all areas that are suitable, or could be made suitable, for office space. A typical layout of a telecommunications master closet is shown in Figure 1 and Figure 2. A typical layout of a telecommunications closet is shown in Figure 3. No telecommunications closet shall be located within another room to which telecommunications specialists cannot gain access (i.e. classroom, office, etc.) with telecommunications issued keys.

7.2. The telecommunications master closet shall be located on the lowest floor capable of being occupied. The telecommunications master closet shall serve as the telecommunications closet for the area around the communications master closet.

7.3. To the extent possible the telecommunications master closet and the telecommunications closets should be located away from exterior walls.

7.4. The area served by the telecommunications master closet and the telecommunications closets is defined as the workspaces that are within 295 cable feet (90 meters) of the serving closet using the duct system designed for the building.

7.5. To the extent possible the telecommunications master closet and the telecommunications closets should be centrally located within the area that is served by the respective closet to minimize the total number of closets within the building.

7.6. The telecommunications master closet and the telecommunications closets shall serve work areas only on the floor where the closet is located.

7.7. To the extent possible the telecommunications master closet and the telecommunications closets shall be rectangular in shape. The minimum floor space of a telecommunications master closet shall be 80 square feet and the telecommunications closet shall be 64 square feet. The minimum length of any wall shall be eight feet.

7.8. All doors for the telecommunications master closet and the telecommunications closets shall be a minimum of 36 inches in width and shall open outward. The door shall contain a self-locking mechanism and shall be keyed to Aeronautical Center lock core as stipulated by AMK-224.

7.9. All walls within the telecommunications master closet and the telecommunications closets shall have floor to ceiling ¾" fire rated plywood with no gaps greater than ½" or ¾" rated plywood with two coats of fire-retardant paint with no gaps greater than ½". Do not paint over label stipulating fire rating on plywood.

7.10. The telecommunications master closet shall be equipped with two seven-foot equipment bays. Telecommunications closets shall be equipped with one seven-foot equipment bay. The equipment bays shall be the standard 19-inch relay rack design. The equipment bay shall be securely attached to the closet floor.

7.11. Equipment bays in telecommunications master closets shall be equipped with switches, level 6 patch panels and fiber terminations panels as required by the area served by the closet. Typical equipment rack layouts are shown in Figure 4. Specifically, equipment bays shall be equipped with one or more Cisco switches, one or more level six patch panels; and one or more fiber patch panels. One patch panel, one Cisco 48 port switch with one year maintenance shall be installed for each 48, or fraction thereof, LAN jacks served by the telecommunications master closet. Sufficient fiber patch panels shall be installed to terminate all fibers installed into the closet. Fiber patch cords shall be provided to connect working GBIC's in the switch to the fiber patch panels. Two Gigabit Interface Converters (GBIC) shall be provided for each stack of four switches or part thereof.

7.12. Equipment bays in telecommunications closets shall be equipped with switches, level 6 patch panels, and fiber terminations panels as required by the area served by the closet. Typical equipment rack layouts are shown in Figure 5. Specifically, equipment bays shall be equipped with one or more

switches; one or more level six patch panels; and one fiber patch panel. One Cisco switch shall be installed for each 48, or fraction thereof, LAN jacks served by the telecommunications closet. One patch panel shall be installed for each 48, or fraction thereof, LAN jacks served by the telecommunications closet.

7.13. Telecommunications master closets and telecommunications closets shall be equipped with a minimum of one 20 Amp (120V NEMA 5-20R) power receptacle on each plywood covered wall. One 20 Amp power receptacle shall be mounted on the base of the equipment rack in each telecommunications closet. Two 30 Amp twist lock power receptacles (120V NEMA L5-30R) shall be mounted on the base of the equipment rack in each telecommunications master closet and one in the IDF closets. One of 20 Amp power receptacle and one 30 AMP power receptacle shall be on an uninterruptible power supply (UPS) power circuit or an emergency generator. The second 20 Amp and 30 Amp power receptacles shall be on commercial power. A minimum of two power circuits shall feed each closet. The power conduits serving the power receptacle(s) on the equipment bays shall be placed in such a way that they do not restrict the placement of equipment in the bay(s) above 12 inches from the floor or the placement of additional equipment bays next to the original equipment bay. The identification of each power circuit shall be clearly and permanently labeled on each receptacle.

7.14. Three runs of four-inch conduit shall be installed between the telecommunications master closet and each telecommunications closet. One of the three new ducts shall be equipped with three inner ducts. The inner duct shall be corrugated style with a 1.25 inch inter diameter. Each inner duct shall be equipped with a continuous pull cord. Each empty conduit shall be equipped with a continuous pull cord.

7.15. A 24-gauge level-three telephone cable, Bell Spec (model number to be supplied by AMK-224), shall be installed between each telecommunications closet and the telecommunications master closet. Both ends of the cable shall be terminated in 110 blocks as shown in Figure 6 and Figure 7.

7.16. A fiber cable as specified by the Telecommunications Division shall be installed between the telecommunications master closet and each telecommunications closet. The cable shall contain a minimum of thirty-six multimode fibers (50 micron) and thirty-six single mode fibers. In the telecommunications master closet the fibers shall be terminated in a fiber termination enclosure. In each telecommunications closet the fibers shall be terminated in a fiber termination enclosure.

7.17. A conduit run shall be constructed between the telecommunications master closet and the telecommunications manhole serving the building. The sizing of the conduit run shall be determined by using the following table and applying the net assignable floor space of the ultimate building.

Net Assignable Floor Space	Conduit Size

Less than 7001	Three 2-Inch
7001 through 63,000	Three 4-Inch
63,001 through 105,000	Four 4-Inch

7.18. When two or more four-inch conduits are constructed between the telecommunications master closet and the serving manhole, one of the four-inch conduits shall be equipped with three inner ducts. The inner ducts shall be outdoor corrugate style with a 1.25 inch inter diameter. Each inner duct shall be equipped with a continuous pull cord. Each empty duct shall be equipped with a continuous pull cord.

7.19. If required, the construction of the manhole and/or other outside plan infrastructure may also be specified.

7.20. Copper cable requirement determination for renovation or new construction will be determined by AMK-224.

7.21. Splice the telephone feeder cable according to the FAA cable splicing procedures cut sheet provided in this document.

7.22. Install a fiber cable between the telecommunications master closet and a remote building specified by the FAA. The fiber cable shall contain a minimum of 36 multimode (50 micron) and 36 single mode fibers.

7.23. Each telecommunications master closet and telecommunications closets shall be equipped with sufficient Heating, Ventilation and Air Conditioning (HVAC) to maintain the temperature within the closet between 60 °F and 80 °F and the relative humidity between 40 % and 60%. These parameters shall be maintained 24x7x365 even if other building HVAC systems are shut down for energy conservation.

7.24. Install an APC Uninterruptible Power Supply (UPS) unit in the telecommunications master closet (model number to be supplied by AMK-224).

7.25. Install an APC Uninterruptible Power Supply (UPS) unit in each telecommunications closet (model number to be supplied by AMK-224).

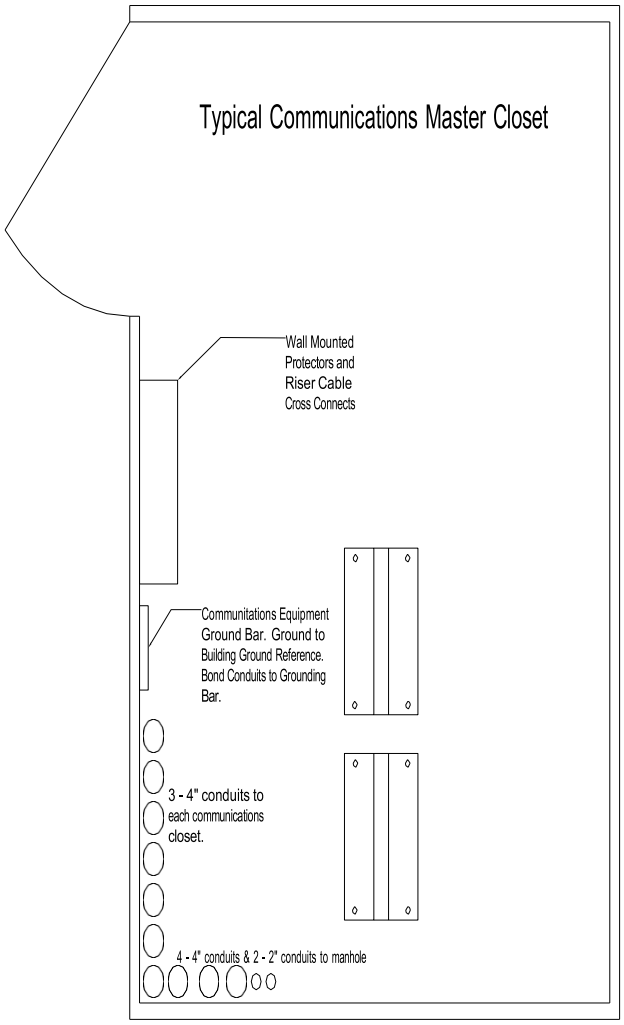


Figure 1 Communications Master Closet Layout

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Check the Master List to Verify That This is the Correct Revision Before Use
Date Printed:
Revision 17 04/16/2024

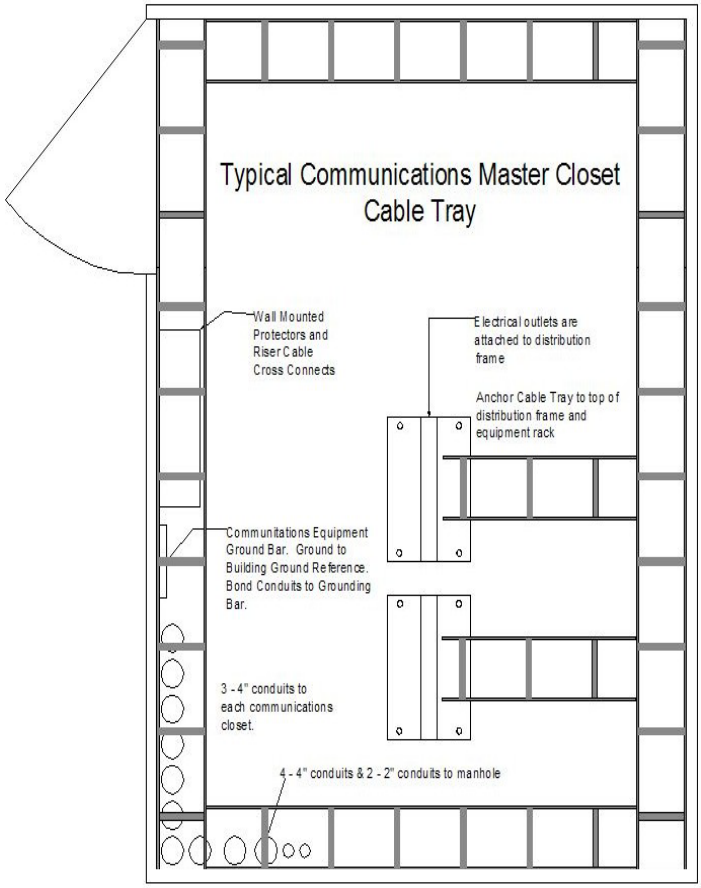

Figure 2

Communications Master Closet Cable Rack Layout

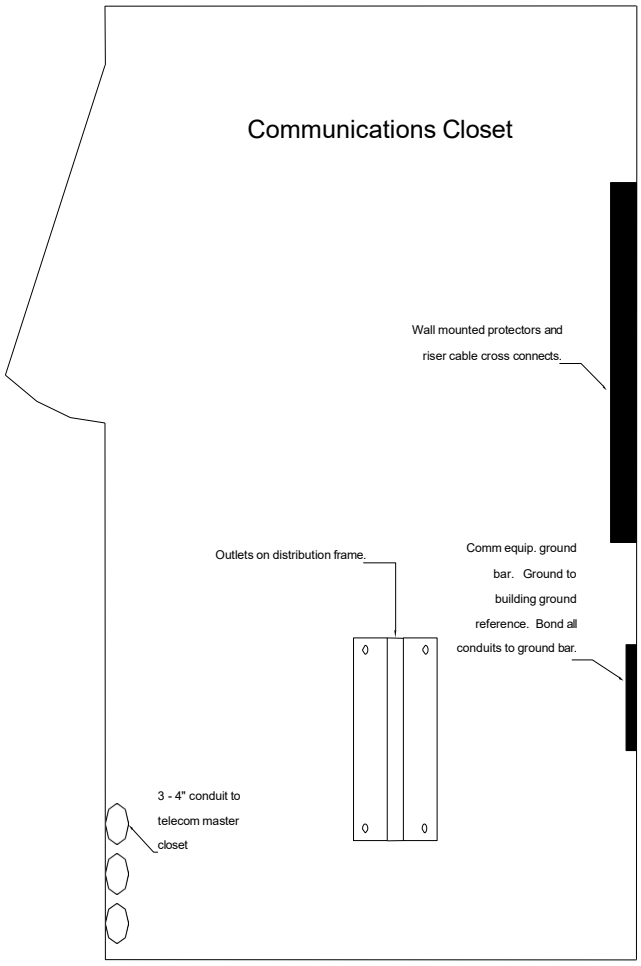

Figure 3 Communications Closet Layout

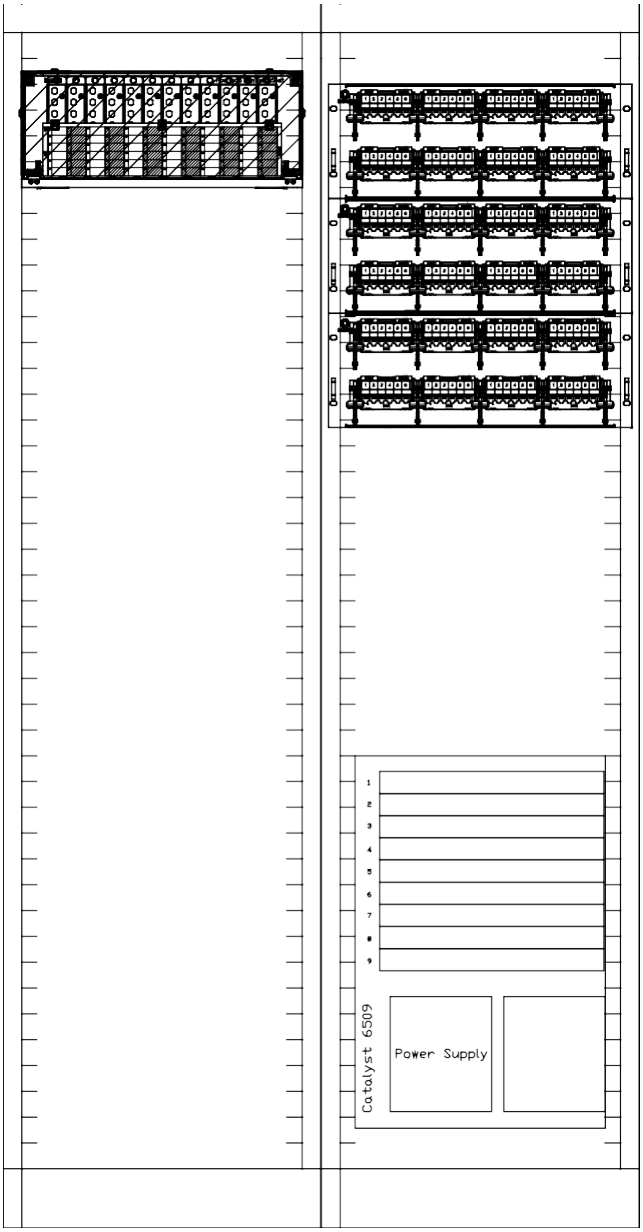

Figure 4 Communications Master Closet Equipment Rack

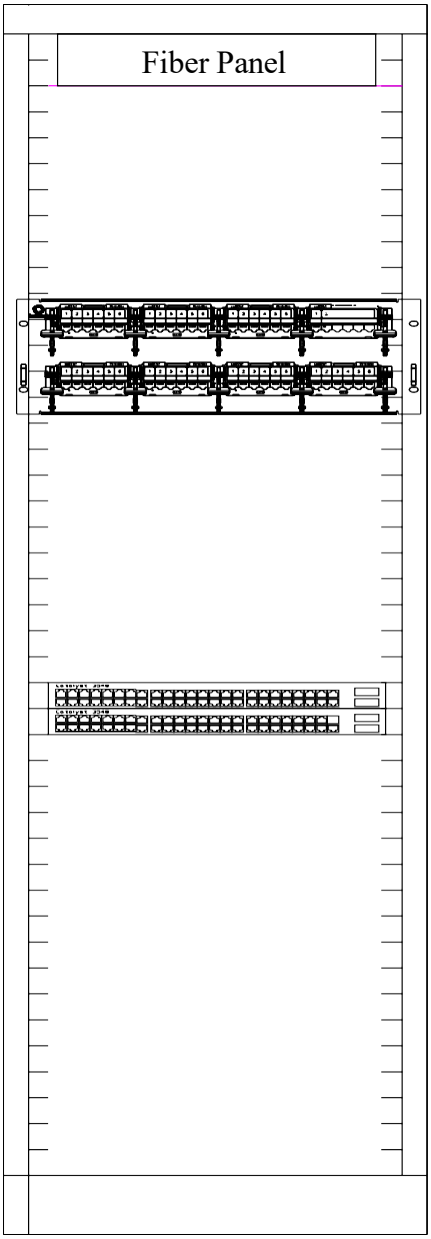

Figure 5 Communications Closet Equipment Rack

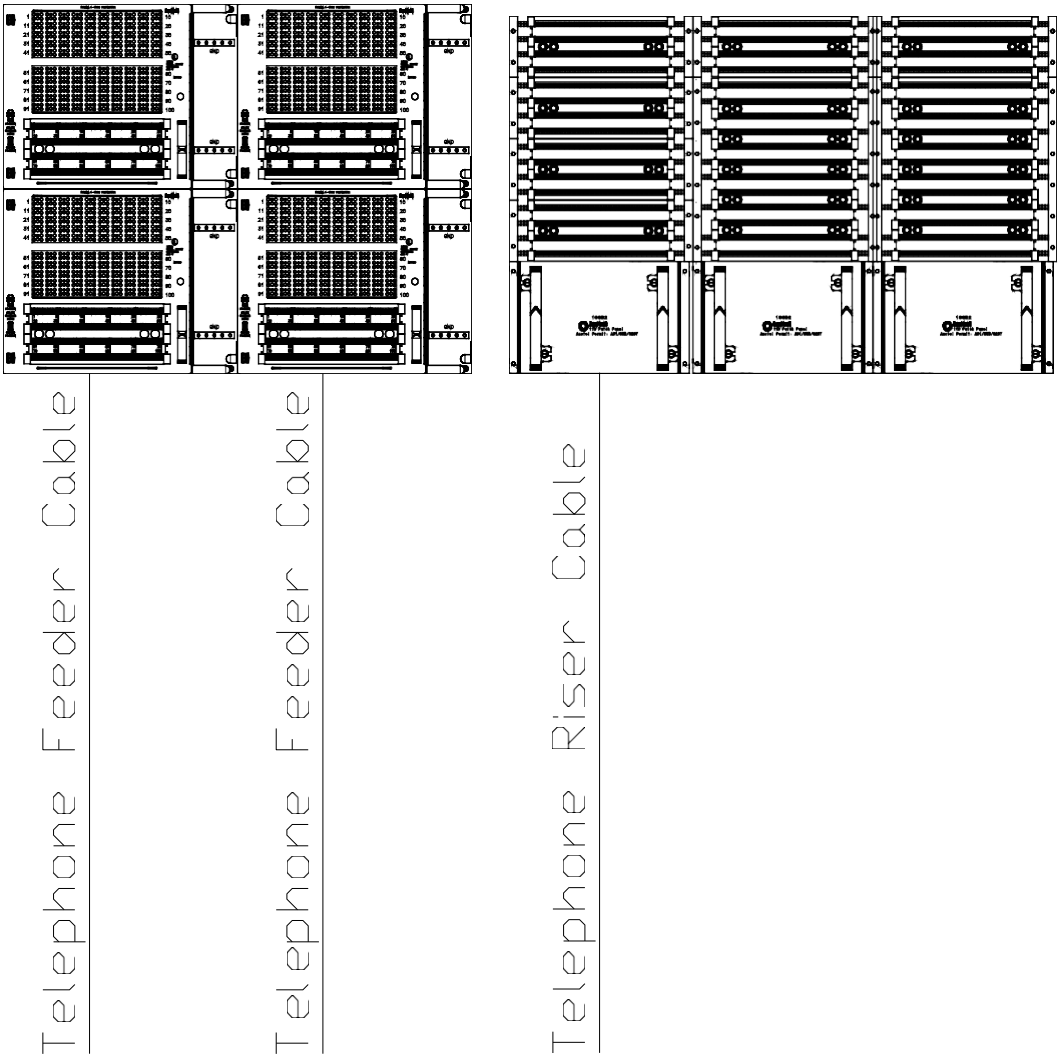

Figure 6 Communications Master Closet Telephone Terminations

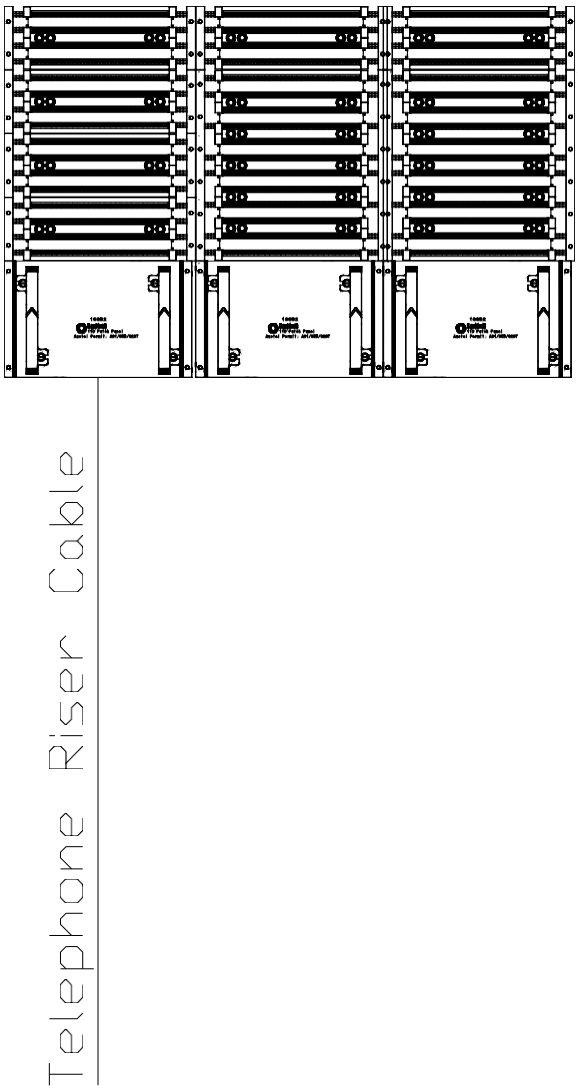

Figure 7 Communications Closet Telephone Terminations

8. FIBER & COPPER FEEDER LABELING SCHEME

8.1. Label all telecommunications infrastructure and equipment components.

8.2. Labeling should provide a unique identifier to prevent it from being confused with other similar cables.

8.3. Make all labels legible and permanent enough to last the life of the component.

8.4. Label all cables at each end with a permanent tag or label, indicating the cable number, building number and pair range. Cables located in handholes/manholes will require waterproof tags in every hole.

8.5. Mark the cable at regular intervals throughout its length (feeder cable number, building number and pair range).

8.5.1. Example Copper Feeder: FDR01- 161- 026-037
Cable# Bldg# Pair Range

8.5.2. Example Fiber Feeder: F2- 161- 120- FDC1
Fiber# Bldg# Room# Terminating Equipment

8.6. Where required, mark the cable at regular intervals with a second label (feeder cable number, manhole number to manhole number or feeder cable number to manhole number to building number to room number).

8.6.1. Example Second Copper Label

FDR01- 01-1000 – MH C3 – MH C4
Feeder Pair Manhole Manhole
Cable Range

FDR01 01-1000 - MH C3 - 1 - BC04
Feeder Pair Manhole Bldg Room
Cable Range # #

8.6.2. Example Second Fiber Label Building To Building

F1- 161- B25- MH C3- 1- BC04
Feeder Bldg Room Manhole Bldg Room

Label Manhole To Manhole

F01- 161- B25 MHC3- MHC4- 1- BC04
Feeder Pair Room Manhole Manhole Bldg Room

8.6.3. FDR01 01-1000 - MH C3 - 1 - BC04

Fiber Label	Feeder Cable	Pair Range	Manhole	Bldg #	Room #

9. TELECOMMUNICATIONS IN SYSTEMS FURNITURE

9.1. Power & Data Distribution

9.1.1. Power and Data: Panels shall have a system capable of distributing power service and data service to multiple workstations through central but separate feed points.

9.1.1.1. Distribution

9.1.1.1.1. Data feeds shall be through separate data poles that extend from the tops of the furniture panels into the ceiling.

9.1.1.1.2. Power feeds shall be through a base feed that connects to a column-mounted junction box. Furniture installer may be required to field cut (drill) path through panel to allow access to j-box in adjacent column.

9.1.1.1.3. Access to the power and data distribution system inside panels and poles shall be easily made and without tools.

9.1.1.1.4. Power and data must be separated by a minimum of twenty-four inches at all points within the panel and base feeds (unless properly separated and shielded or approved in writing by the FAA prior to bidding). The power and data cables shall NOT cross each other.

9.1.1.1.5. Data Cable Management: Power/Data poles shall have a data channel that is properly separated and shielded from electrical sources in accordance with EIA/TIA standards. Panels shall offer the following capacities for routing data cables.

9.1.1.1.6. Panel Top Pathways: All data horizontal pathways shall be in dedicated channels. Dedicated channel pathways shall be a minimum of 1.6” (40.6mm) deep and have a capacity of a minimum of thirty-one (31) Category 6 – 0.25” (6.35mm) diameter cables at 60% fill. Exceptions are glazed panels and doors which shall have a minimum of 1.4” (35.6mm) deep pathway and a capacity of a minimum of twenty-seven (27) Category 6 – 0.25” (6.35mm) cables.

9.1.1.1.7. Panel Vertical Pathways: Panel vertical pathways provide a channel for routing cables from the top pathway to base pathways, or to port openings on the panel face. Vertical pathways shall provide a minimum capacity of seventeen (17) Category 6 – 0.25" (6.35mm) diameter cables.

9.1.1.1.8. Furniture vendors shall provide flush mounted faceplates, bezel, and blank covers capable of accepting standard Aeronautical Center data receptacles.

9.1.1.1.9. Knockout plates in the panel face shall be capable of providing a minimum of six potential jacks per workstation. Data receptacles shall include the following:

9.1.1.1.9.1. Furniture vendor shall supply three (3) RJ45 Systimax Part #MGS400BH-112 (Orange) at each position location.

9.1.1.1.9.2. Furniture vendor shall supply one (1) Blank Systimax Part #107067860 at each position location.

9.1.1.1.9.3. Only data jacks with these part numbers will be accepted.

9.1.1.1.9.4. Data outlets can be installed without damage to the panel face.

9.1.1.1.9.5. Data Poles: Data poles with appropriate trim pieces shall extend from the top of the panel to the ceiling height (+/- 11'-0" AFF field verify). Data poles shall have a minimum capacity of thirty-one (31) CAT6 – 0.25" (6.35mm) diameter cables at 60% fill.

SECTION 27 00 10

SUPPLEMENTAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Supplemental requirements generally applicable to the Work specified in Division 27.

B. Related Requirements:

1. Work specified in the following Division 26 sections are related to Work specified in Division 27:

a. Section 26 00 10 "Supplemental Requirements for Electrical" for abbreviations and acronyms for electrical terms and units of measure, abbreviations and acronyms for electrical raceway types, abbreviations and acronyms for electrical cable types, definitions, and additional coordination drawing submittal requirements.
b. Section 26 00 11 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work.

1.2 REFERENCES

A. Abbreviations and Acronyms for Communications:

1. LAN: Local area network.
2. PoE: Power over Ethernet.
3. POTS: Plain old telephone service. See "public switched telephone network."
4. TCP/IP: Transmission control protocol/Internet protocol.
5. WAN: Wide area network.

B. Definitions for Communications:

1. Calling Party Control (CPC): A momentary break in phone line loop current, which is used to signal voicemail and other automated telephone company services that distant party has hung up.
2. Private Branch Exchange (PBX): Analog telephone switch that routes calls internal to a business or organization so a direct external line for each phone is unnecessary.
3. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted-pair cables from a telephone-provider central office for the

transmission medium. PSTN refers to the telephone network; POTS refers to the individual subscriber line.

4. Remote Office Phone System (ROPS): VoIP system that allows phones for a business or organization located anywhere in the world with internet connectivity to behave similar to phones connected to a PBX.
5. Ringer Equivalence Number (REN): The loading effect of a single traditional telephone ringing circuit. TIA-968 defines REN 1 as an impedance of 7000 Ω at 20 Hz (Type A ringer) or 8000 Ω from 15 Hz to 68 Hz (Type B ringer). The sum of the RENs for all devices on a subscriber line circuit may not exceed the maximum permitted REN for the subscriber line.
6. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.

1.3 PREINSTALLATION MEETINGS

1. Value analysis proposals and requests for substitution of communications equipment.
2. Utility services work coordination and monitoring service requests.
3. Commissioning activities.
4. Sustainability activities.

1.4 ACTION SUBMITTALS

A. Coordination Drawings: Submit multidiscipline coordination drawings depicting communications equipment, devices, cabling, conduit, and duct banks in accordance with requirements specified in Section 26 00 10 "Supplemental Requirements for Electrical."

1.5 INFORMATIONAL SUBMITTALS

A. Installation schedule for communications systems.

B. Qualification statements.

C. Seismic-load performance certificates.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. Qualifications: Prepare and submit qualification statements for the following entities performing Work on Project:

1. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 01 40 00 "Quality Requirements," that maintains a service

center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.

2. Communications Design Professional: Design professional possessing active qualifications specified in Section 01 40 00 "Quality Requirements" and the following:

    a. Expertise in design of communications infrastructure and distribution equipment.
    b. BICSI Registered Communications Distribution Designer (RCDD) certification.

3. Communications Cable Installer: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" and the following:

    a. Training and manufacturer certification to install, splice, and terminate communications cabling.
    b. Installation Supervisor: BICSI Technician (TECH) certification.
    c. Copper Installers: 30 percent of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
    d. Fiber Installers: 30 percent of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.

4. Communications Cable Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

    a. On-site communications cable testing supervisor must have BICSI Technician (TECH) certification and documented training, and be experienced with testing communications equipment in accordance with BICSI testing standards.

5. Structural Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing structural concrete, seismic controls, and wind-load controls.

B. Certifications:

1.8 FIELD CONDITIONS

A. Modeling, analysis, product selection, installation, and quality control for Work specified in Division 27 must comply with requirements specified in Section 26 00 11 "Facility Performance Requirements for Electrical."

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR COMMUNICATIONS EQUIPMENT

A. Substitution requests for communications equipment will be entertained under the following conditions:

1. Notification of Contractor's intent to request substitutions for convenience must be declared during the Communications Preconstruction Conference so potential risks to system performance and construction schedule may be identified for Contractor's response in submission of the substitution request. Submission of requests for substitutions for convenience must meet the conditions and deadline specified in Section 01 25 00 "Substitution Procedures" to receive approval.
2. For communications equipment and systems, substitutions for cause are considered major construction risks. If it is possible that Contractor may need to request substitutions for cause because of equipment unavailability, or inability to meet construction schedule because of lead time, Contractor must declare the possibility during the Communications Preconstruction Conference to permit establishing a mitigation plan for minimizing risks to system performance and construction schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. All verification shall be done in accordance with AMKFM-224001.

B. Preinstallation Testing:

1. All testing shall be done in accordance with AMKFM-224001.

C. Evaluation and Assessment:

1. All evaluations and assessments shall be done in accordance with AMKFM-224001.

3.2 PREPARATION

A. Installation Schedule for Communications Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of communications Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 27.
3. Orders placed for major equipment.

4. Arrival of major equipment on-site.
5. Preinstallation meetings specified in Division 27.
6. Telephone and internet service outages.
7. Telephone and internet service inspection and activation.
8. Mockup reviews.
9. Closing of walls and ceilings containing communications Work.
10. System startup, testing, and commissioning activities for communications equipment.
11. System startup, testing, and commissioning activities for Work specified in other divisions that depend on Work specified in Division 27.
12. System startup, testing, and commissioning activities for automation systems (for example, SCADA, BMS, lighting, HVAC, fire alarm, or fire pump).
13. Requests for special inspections.
14. Requests for inspections by authorities having jurisdiction.

3.3 INSTALLATION OF COMMUNICATIONS WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' instructions, comply with NFPA 70, NECA NEIS 1, and BICSI N1 for installation of Work specified in Division 27. Consult Architect for resolution of conflicting requirements.

3.4 FIELD QUALITY CONTROL

A. Administrant for Communications Tests and Inspections:

1. Engage qualified communications cable testing and inspecting agency to administer and perform tests and inspections.

3.5 CLEANING

A. Waste Management:

1. Waste Management" Paragraph with Section 01 74 19 "Construction Waste Management and Disposal.

3.6 CLOSEOUT ACTIVITIES

A. Operation and Maintenance Data: Prepare and submit the following:

1. Include emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:

    a. Telecommunication Equipment.
    b. Public Address System

2. Include the following information:

a. Manufacturer's operating specifications.
b. User's guides for software and hardware.
c. Schedule of maintenance material items recommended to be stored at Project site.
d. Detailed instructions covering operation under both normal and abnormal conditions.
e. Manufacturer's instructions for setting field-adjustable components.
f. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
g. Include copies of demonstration and training videos.

B. Training:

1. Train Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain public address system equipment specified in Section 27 51 16 "Public Address System."

END OF SECTION

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Selection and installation of communications busbars.
2. Selection and installation of communications bonding conductors.
3. Selection of signal reference grids.
4. Installation of grounding and bonding for towers and antennas.

B. Related Requirements:

1. Section 26 00 11 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 27 00 10 "Supplemental Requirements for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.

B. PBB: Primary bonding busbar, located in main distribution frame room, ideally near electrical service entrance.

C. RBB: Rack bonding busbar, located in equipment cabinets and racks.

D. SBB: Secondary bonding busbar, located in intermediate distribution frame rooms.

E. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.

F. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.

G. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.

H. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. For communications equipment room signal reference grid.
2. Include plans, elevations, sections, details, and attachments to other work.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Installing wire connector on conductor.
2. Recommended torque values.

1.5 CLOSEOUT SUBMITTALS

A. Record Documentation: Project record documents in accordance with Section 01 78 39 "Project Record Documents" must include locations of PBB and SBBs, and routing of TBC, TBBs, and BBCs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of TBC connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of TBC only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF COMMUNICATIONS BUSBARS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. PBB:

1. Dimensions: 1/4 inch thick by 4 inch high.
2. Stand-Off Distance: 4 inch.

C. SBB:

1. Dimensions: 1/4 inch thick by 4 inch high.
2. Stand-Off Distance: 2 inch.

3.3 SELECTION OF COMMUNICATIONS BONDING CONDUCTORS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Communications Busbar Connections:

1. TBC: Not smaller than 1/0 AWG and no smaller than largest TBB.
2. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
3. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
4. TEBC: Not smaller than 2 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
5. UBC: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
6. Bonding Conductors to Structural Steel: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted clamp connectors.

3.4 SELECTION OF SIGNAL REFERENCE GRIDS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.5 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. NFPA 70
2. NECA NEIS 1
3. ANSI/TIA-607

C. Special Techniques:

1. Busbars:

a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 12 inch above finished floor unless otherwise indicated.
b. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

2. Conductors:

a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:

1) Use crimping tool and die specific to connector.
2) Pretwist conductor.
3) Apply antioxidant compound to bolted and compression connections.

c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
d. Install without splices.
e. Support conductors at not more than 36 inch intervals.
f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-A or EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.

1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing that complies with Section 27 05 28 "Pathways for Communications Systems," and bond both ends of raceway to SBB.

3. Provide TBC and terminate ends to PBB and intersystem bonding termination device at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.

3.6 IDENTIFICATION

A. Comply with Section 27 05 53 "Identification for Communications Systems."

B. Labels must be preprinted or computer-printed type.

1. Label PBB(s) with "ts-PBB," where "ts" is telecommunications space identifier for location of PBB.

2. Label SBB(s) with "ts-SBB," where "ts" is telecommunications space identifier for location of SBB.
3. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.7 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer's published instructions.
2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.

    a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 mΩ.

        1) If measured resistance from electrical service equipment to ground exceeds 5 Ω, notify Architect and include recommendations to reduce resistance to ground.

    b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 mΩ.

3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.

    a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB. Maximum acceptable AC current level is 1 A.

C. Nonconforming Work:

1. Communications bonding will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports.

3.8 PROTECTION

A. After installation, protect busbars and conductors from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

1.1 SUMMARY

A. Section Includes:

1. Type OFR and Type CR communications raceways and fittings.
2. Cable supports and positioning devices.

B. Related Requirements:

1. Section 27 00 10 "Supplemental Requirements for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 07 84 13 "Penetration Firestopping" specifies firestopping for communications pathways installed by this Section.
3. Section 26 05 26 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding conductors and connectors for communications pathways installed by this Section.
4. Section 26 05 29 "Hangers and Supports for Electrical Systems" specifies hangers and supports for communications pathways installed by this Section.
5. Section 26 05 33.13 "Conduits for Electrical Systems" specifies the following installed by this Section:

    a. Type EMT-A and Type EMT-SS duct raceways and elbows.
    b. Type EMT-S duct raceways and elbows.
    c. Type ENT duct raceways and fittings.
    d. Type HDPE and Type EPEC duct raceways and fittings.
    e. Type ERMC-A and Type ERMC-SS duct raceways, elbows, couplings, and nipples.
    f. Type ERMC-S duct raceways, elbows, couplings, and nipples.
    g. Type FMC-S and Type FMC-A duct raceways.
    h. Type FMT duct raceways.
    i. Type IMC duct raceways.
    j. Type LFMC duct raceways.
    k. Type LFNC duct raceways.
    l. Type PVC duct raceways and fittings.
    m. Type RTRC-AG duct raceways and fittings.
    n. Type RTRC-BG duct raceways and fittings.
    o. Fittings for conduit, tubing, and cable.
    p. Electrically conductive corrosion-resistant compounds for threaded conduit.
    q. Solvent cements.

6. Section 26 05 33.16 "Boxes and Covers for Electrical Systems" specifies the following installed by this Section:

    a. Metallic outlet boxes, device boxes, rings, and covers.

b. Nonmetallic outlet boxes, device boxes, rings, and covers.
c. Junction boxes and pull boxes.
d. Cover plates for device boxes.
e. Hoods for outlet boxes.

7. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" specifies the following installed by this Section:

a. Duct accessories.
b. Handholes and boxes for exterior underground wiring.
c. Manholes for exterior underground wiring.
d. Utility structure accessories.
e. Duct sealing.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

1) If listed manufacturer differs from selling manufacture, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.

B. Samples:

1. Type OFR and Type CR Raceways: For each color and texture specified, 12 inch (300 mm) long.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions submittals.

PART 2 - PRODUCTS

2.1 TYPE OFR AND TYPE CR COMMUNICATIONS RACEWAYS AND FITTINGS

A. Description: This product group covers raceways and fittings for installation of conductive and nonconductive optical-fiber cable, communications cable, power-limited fire-alarm cable, signaling cable, and coaxial cable in accordance with NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:

    a. Optical-Fiber Cable Raceway: UL CCN QAZM; including UL 2024.
    b. Communications Cable Raceway: UL CCN QBAA; including UL 2024.

C. UL QBAA - Type CR-GP General-Purpose Communications Cable Raceway:

1. Cable Runway Ladder Rack 9' x 11.5" x 12' model number CPI 10250-712.
2. Product Characteristics:

    a. Texture: Smooth.
    b. Splicing: Cable Runway Junction Splice Kit Gold model number CPI 16302-001.

3. Required Product Options:

    a. Couplings and Fittings:

        1) Cable Runway Mounting Plate 12" w/Angle Support Kit model number CPI 11421-712.

        2) Cable Runway J-Bolt Kit, Runway to Wall Support Bracket model number CPI 11308-001

        3) Cable Runway End Caps model number CPI 10642-001

    b. Colors:

        1) For Communications: White.

2.2 CABLE SUPPORTS AND POSITIONING DEVICES

A. Description: This category covers straps, hooks, and similar types of hardware for installation and use in communications cabling systems in accordance with NFPA 70 and manufacturer's installation instructions

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. UL DWMU - Conduit:

1. Product Listing Criteria: UL CCN DWMU; including UL 2239 or UL 1565.
2. Product Characteristics:

    a. Mounting Orientation: Vertical and/or Horizontal.
    b. Conduit, Cable, or Tubing Bundle Capacity: .

3. Required Product Options:

    a. Suitable for use in air handling space.

PART 3 - EXECUTION

3.1 SELECTION OF PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Type OFR and Type CR Communications Raceways: Comply with Table 800.154(b) of NFPA 70.

C. Minimum Pathway Size:

1. For Copper and Aluminum Cables: Metric designator 21 (trade size 3/4).
2. For Optical-Fiber Cables: Metric designator 25 (trade size 1).

D. Maximum Pathway Length Between Cable Access Points: 75 ft (23 m).

E. Temperature Limitations:

1. Type PVC, Type HDPE, Type EPEC, Type OFR, and Type CR: Do not install where ambient temperature exceeds 122 deg F (50 deg C). Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
2. Type RTRC: Do not install where ambient temperature exceeds 230 deg F (110 deg C).

F. Outdoor Pathways:

1. Exposed and Subject to Severe Physical Damage: ERMC.
2. Exposed and Subject to Physical Damage: ERMC.

    a. Locations less than 2.5 m (8 ft) above finished floor.

3. Exposed and Not Subject to Physical Damage: ERMC or IMC.
4. Concealed Aboveground: ERMC, IMC, or EMT.
5. Direct Buried: PVC-40.
6. Concrete Encased Not in Trench: RMC.
7. Concrete Encased in Trench: PVC-40 when ductbank does not cross under roadways and RMC when entering a building or under a roadway.
8. Innerducts inside Other Raceway: ENT.

G. Indoor Pathways:

1. Hazardous Classified Locations: ERMC.
2. Exposed and Subject to Severe Physical Damage: ERMC. Locations include the following:

    a. Loading docks.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.

3. Exposed and Subject to Physical Damage: ERMC. Locations include the following:

    a. Locations less than 2.5 m (8 ft) above finished floor.
    b. Stub-ups to above suspended ceilings.

4. Exposed and Not Subject to Physical Damage: ERMC, IMC, or EMT.
5. Concealed above Suspended Ceilings: ERMC, IMC, or EMT.
6. Concealed in Ceilings and Interior Walls and Partitions: ERMC, IMC, or EMT.
7. Damp or Wet Locations: ERMC, IMC, or EMT.
8. Innerducts inside Metal Raceway: ENT.
9. In Vertical Runs: ERMC, IMC, or EMT.

H. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

I. Cable Supports and Positioning Devices:

1. Size hooks to allow minimum of 25 percent future capacity without exceeding design capacity limits.
2. Support hooks directly from building structure. Do not use ceiling grid support rods or wires.
3. Hook spacing must allow no more than 6 inch (150 mm) of slack. Lowest point of cables must be no closer than 6 inch (150 mm) to ceiling tiles, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 ft (1.5 m) on center.
5. Provide hook at each change in direction.

J. Boxes and Enclosures:

1. Outdoors, Aboveground: UL 50E Type 3R.
2. Indoors: UL 50E Type 1, except use Type 4 nonmetallic units in institutional and damp or wet locations.

K. Identification of Underground Pathways, Handholes, and Structures:

1. Use "COMMUNICATIONS" for legend on warning planks, underground warning tape, and covers.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

A. Grounding and Bonding Conductors:

1. Communications Busbar Connections:

a. TBC: Not smaller than 1/0 AWG and no smaller than largest TBB.
b. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
c. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
d. TEBC: Not smaller than 2 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
e. UBC: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
f. Bonding Conductors to Structural Steel: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted clamp connectors.

2. Underground Connections: Not smaller than 2 AWG. Provide welded connectors, except bolted connectors may be used in handholes or manholes and as otherwise indicated on Drawings.

3.3 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft (2.3 m) above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1 and IEEE C2.

C. Color Coding Scheme for Communications Cable and Terminations: Comply with BICSI N1 and TIA-598.

D. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "COMMUNICATIONS."
2. "SECURITY."

E. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

F. Locations of Underground Lines: Underground-line warning tape for communication, control wiring, and optical-fiber cable.

G. Communications Vaults, Manholes, Handholes, and Pull and Junction Boxes: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.

H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.

I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with conductor designation.

J. Equipment and Cabling Identification for Administrative Records and Labeling: Comply with TIA-606 requirements for Class 2 network administration.

K. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: Laminated acrylic or melamine plastic sign.
3. Outdoor Equipment: Laminated acrylic or melamine sign.
4. Equipment To Be Labeled:

a. Racks, Frames, and Enclosures: Identify front and rear of each enclosure with self-adhesive labels.
b. Patch Panels: Labeling should follow owner standard AMKFM-224001.
c. Communications cabinets.
d. Access doors and panels for concealed communications items.
e. Emergency system boxes and enclosures.
f. Remote-controlled switches, dimmer modules, and control devices.
g. Monitoring and control equipment.
h. Security equipment.
i. Life-safety communications equipment.

L. Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

M. Horizontal Cables: Label each cable with a vinyl-wraparound label.

N. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Identify cover plate in accordance with TIA-606.

O. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.4 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT/RACK HAS MULTIPLE POWER SOURCES."

D. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.

E. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for.

3.5 INSTALLATION OF PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. Comply with manufacturers' published instructions, including limitations on distance, bends, and bend radius.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Type OFR Optical-Fiber Raceways: Article 800 of NFPA 70 and BICSI N1.
2. Type CR Communications Raceways: Article 800 of NFPA 70 and BICSI N1.
3. Cable Supports and Positioning Devices: Article 800 of NFPA 70 and BICSI N1.
4. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Complete communications raceway installation before starting conductor installation.
2. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3. Provide hangers and supports for pathways, boxes, and enclosures.
4. Firestop pathway penetrations of fire-rated assemblies.

    a. Provide safety warning signs.
    b. Bury underground warning tape approximately 18 inch (457 mm) above direct-buried conduits, but minimum of 6 inch (150 mm) below grade. Align tape along centerline of conduit.

D. Interfaces with Other Work:

1. Coordinate installation of new communications pathways with existing conditions.
2. Grounding and Bonding: Bond metallic communications boxes and enclosures to metallic pathways. Coordinate with Section 27 11 00 "Communications Equipment Room Fittings" for grounding and bonding of communications pathways to communications equipment room fittings.

3.6 PROTECTION

A. Protect coatings and finishes of pathways, boxes, and enclosures from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 27 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

1.1 SUMMARY

A. Products Installed, but Not Furnished, under This Section:

1. See Section 26 05 33.13 "Conduits for Electrical Systems" for the following:

   a. Type ENT duct raceways and fittings.
   b. Type HDPE and Type EPEC duct raceways and fittings.
   c. Type ERMC-S duct raceways, elbows, couplings, and nipples.
   d. Type IMC duct raceways.
   e. Type PVC duct raceways and fittings.
   f. Type RTRC-AG duct raceways and fittings.
   g. Type RTRC-BG duct raceways and fittings.
   h. Fittings for conduit, tubing, and cable.
   i. Threaded metal joint compound.
   j. Solvent cements.

2. See Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for the following:

   a. Handholes and boxes for exterior underground wiring.
   b. Manholes for exterior underground wiring.
   c. Utility structure accessories.

B. Related Requirements:

1. Section 26 00 11 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 27 00 10 "Supplemental Requirements for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Conduit: A structure containing one or more duct raceways.

B. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

C. Duct Raceway: A single enclosed raceway for conductors or cable.

D. Handhole: In-ground structure with less than 2 m (6.5 ft) floor-to-ceiling working clearance.

E. Innerduct: A smaller tube used to subdivide large ducts into a conduit system for segregated placement of communications cables.

F. Manhole: In-ground structure with at least 2 m (6.5 ft) floor-to-ceiling working clearance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SELECTION OF UNDERGROUND DUCTS AND ACCESSORIES FOR COMMUNICATIONS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of underground ducts and accessories. Consult Architect for resolution of conflicting requirements.

B. Direct Buried: PVC-40.

C. Concrete Encased Not in Trench: PVC-40.

D. Concrete Encased in Trench: PVC-40.

E. Duct Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERMC and IMC: Provide threaded-type fittings unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths, Walks, and Driveways: PVC-40, encased in reinforced concrete.

G. Underground Ducts Crossing Roadways and Railroads: PVC-40, encased in reinforced concrete.

H. Stub-ups: Concrete encased, PVC-40.

I. Communication Innerducts: HDPE-40 or EPEC-A.

J. Underground-Line Warning Tape: In accordance with Section 27 05 53 "Identification for Communications Systems."

K. Concrete Warning Planks: In accordance with Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems," except mark each plank with "COMMUNICATIONS".

3.2 SELECTION OF HANDHOLES AND BOXES FOR COMMUNICATIONS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Provide handholes and boxes in accordance with Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems," except for the following:

1. Cover Legend: "COMMUNICATIONS".
2. Color: Green.
3. Degree of Protection for Boxes:

    a. Locations in-Ground or Exposed to Corrosive Agents: Type 3RX.
    b. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

3.3 SELECTION OF UNDERGROUND STRUCTURES AND ACCESSORIES FOR COMMUNICATIONS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of underground structures and accessories. Consult Architect for resolution of conflicting requirements.

B. Provide underground structures and accessories in accordance with requirements specified in Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems," except for the following:

1. Cover Legend: "COMMUNICATIONS".

3.4 INSTALLATION

A. Earthwork: Comply with Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems."

B. Installation of Duct Raceways and Duct Banks: Comply with Section 26 05 33.13 "Conduits for Electrical Systems" and Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems."

C. Installation of Structures: Comply with Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Comply with Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems."

3.6 CLEANING

A. Comply with Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems."

END OF SECTION

SECTION 27 11 16

COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

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. 23-inch freestanding equipment cabinets.
2. Power strips.
3. Grounding.
4. Labeling.

B. Related Requirements:

1. Section 27 05 26 "Grounding and Bonding for Telecommunications Equipment" for TMGBs and TGBs.
2. Section 27 13 13 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
3. Section 27 13 23 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
4. Section 27 15 13 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, 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. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.

3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to Seismic Design Category C.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. UL listed.

C. RoHS compliant.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 06 10 00 "Rough Carpentry."

2.3 23-INCH EQUIPMENT CABINETS

A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with 23-inch equipment mounting.

B. Z4-Series Seismic Frame Cabinet System model number Z4-11N-103C-C10

C. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Modular Freestanding Cabinets:

1. Overall Height: 72 inches.
2. Overall Depth: 41.3 inches.
3. Load Rating: 3000 lb.
4. Number of Rack Units: As indicated on Drawings.

a. Numbering: Every five rack units, on interior of rack.

5. Threads: 10-32 or 12-24.
6. Removable and lockable side and top panels.
7. Hinged and lockable front and rear doors.
8. Adjustable feet for leveling.
9. Screened ventilation openings in roof and rear door.
10. Cable access provisions in roof and base.
11. TGB.
12. Rack-mounted, 550-cfm fan with filter.
13. Power strip.
14. All cabinets keyed alike.

E. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.

2.5 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.6 LABELING

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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

3.3 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 27 05 53 "Identification for Electrical Systems."

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.

D. Labels shall be machine printed. Type shall be 1/8 inch in height.

END OF SECTION

SECTION 27 13 13

COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backbone communications cables.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Products Installed, but Not Furnished, under This Section:

1. See Section 27 05 53 "Identification for Communications Systems" for communications equipment labels.
2. See Section 27 15 13 "Communications Copper Horizontal Cabling" for Type CM, CMG, and CMX cabling.

C. Related Requirements:

1. Section 26 00 11 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 27 00 10 "Supplemental Requirements for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Cable Types:

1. FTP: Foil shielded twisted pair.
2. F/FTP: Bundle of FTP cables with overall foil shield.
3. F/UTP: Bundle of UTP cables with overall foil shield.
4. S/FTP: Bundle of FTP cables with overall braided shield.
5. S/UTP: Bundle of UTP cables with overall braided shield.
6. UTP: Unshielded twisted pair.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

1.3 SEQUENCING

A. Wet-work in spaces must be completely dry, and HVAC system must be operating and maintaining ambient temperature and humidity conditions within manufacturer's recommended limits, before delivering and installing cables and connecting materials.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Shop Drawings:

1. Cable labeling schedules.
2. Cabling administration diagrams.
3. Wiring diagrams.
4. Cross-connect and patch panel details.
5. Twisted-pair cable testing plan.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions:

1. Backbone communications cable.
2. Communications-, audio/video-, data-, and other signaling-circuit accessories.

B. Field Reports:

1. Factory Test Reports:

    a. Backbone communications cable.

1.6 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.7 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.

1.8 WARRANTY FOR COMMUNICATIONS COPPER BACKBONE CABLE ASSEMBLIES

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed communications copper backbone cable assemblies perform in accordance with specified requirements and agrees to repair or replace cable assemblies that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 BACKBONE COMMUNICATIONS CABLES

A. Description: This category covers multiple conductor jacketed communications cable for telephone and other communications circuits for use in risers and plenums as described in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. Listing Criteria:

a. Certified Cable: UL CCN DUZX; including UL 444.
b. Verified Cable: UL CCN DVBI; including TIA-568.2.
c. Type CMP: NFPA 262.
d. Type CMR: UL 1666.
e. Limited Smoke: Marked "-LS" in accordance with UL 1685.
f. Halogen-Free: Marked "-HF" in accordance with UL Subject 2885.
g. Low Smoke and Halogen-Free: Marked "-LSHF" in accordance with IEC 61034-2.
h. Cable Heating Test: Marked "-LP" with current rating and temperature rating.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

3. Factory Tests:

a. Testing Administrant: Engage qualified electrical testing agency to evaluate cable reels.
b. Factory Tests and Inspections: Test and inspect cable on reels, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-568.2 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
c. Nonconforming Work:

1) Cable reels that do not pass tests and inspections will be considered defective.

d. Factory Test Reports: Prepare and submit factory test and inspection reports.

D. UL DUZX and DVBI - Type CMP, Category 5e Communications Cable:

1. 24 AWG, Level 3, Anixter # CMR-02004EAA
2. Product Marking: Type CMP; Category 5e.
3. Options:

a. Quantity of Pairs: 25.
b. Shielding/Screening: FTP.
c. Jacket: Gray thermoplastic.

2.2 COMMUNICATIONS-, AUDIO/VIDEO-, DATA-, AND OTHER SIGNALING-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for use in residential or commercial communications-station applications for connections to communications circuit as defined in Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

a. Communications-Circuit Accessories: UL CCN DUXR; including UL 1863.
b. Audio/Video-, Data-, and Other Signaling-Circuit Accessories: UL CCN DUXR; including UL 1977.
c. For Use in Air-Handling Spaces: UL 2043.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

D. UL DUXR - Connecting Block:

1. Options:

a. Configuration: 110-style IDC for Category 5e.
b. Quantity of Terminations: Number of cables terminated on block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. UL DUXR - Patch Panel:

1. General Characteristics:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.
e. Construction: 16-gauge steel and mountable on 19 inch (483 mm) equipment racks.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following:

1. Cable Labeling Schedules: Submit electronic files using software and format requested by Owner.
2. Cabling Administration Diagrams: Submit diagrams and supporting electronic files using software and format requested by Owner.

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

3. Wiring Diagrams:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Cross-connects.
f. Patch panels.
g. Patch cords.

4. Cross-Connect and Patch Panel Details: Include mounting assemblies, elevations, and physical relationship between installed components.
5. Twisted-Pair Cable Testing Plan: Include list of cables to be tested, identification of tests to be performed, pass/fail criteria, and copy of testing procedures (may be separate volume). Indicate Installer's required tests for warranty compliance.
6. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.
7. Generate shop drawings in AutoCAD. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings in hard copy and an electronic copy. Electronic copies are to be written to a USB device if they cannot be provided through a shared drive.

3.2 INSTALLATION OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation:

1. Communications Cable Assemblies: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N1.
2. Consult Architect for resolution of conflicting requirements.
3. Comply with owner telecom standard document AMKFM-224001.

C. Special Installation Techniques:

1. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

    a. Provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
    b. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

2. Drawings indicate general arrangement of pathways and fittings.
3. Wiring Methods:

    a. Raceway and Tray: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. 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 27 05 28 "Pathways for Communications Systems."

b. Open-Cable: Route conductors and cables in accessible ceilings, walls, and floors where possible.

c. 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 cables parallel with or at right angles to sides and back of enclosure.

4. General Requirements for Cabling:

a. Install 110-style IDC termination hardware unless otherwise indicated.
b. Do not untwist twisted-pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
c. Terminate all conductors; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
d. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch (760 mm) and not more than 6 inch (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
e. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
f. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Use lacing bars and distribution spools.
g. 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.
h. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
i. In the communications equipment room, install 10 ft (3 m) long service loop on each end of cable.
j. Pulling Cable: Monitor cable pull tensions.

5. Open-Cable Installation:

a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
b. Suspend twisted-pair cabling, not in a wireway or pathway, a minimum of 8 inch (200 mm) above ceilings by cable supports not more than 5 ft (1.5 m) apart.
c. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

6. Group connecting hardware for cables into separate logical fields.
7. Separation from EMI Sources:

a. Comply with BICSI N1 for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
b. Separate open communications cables or cables in nonmetallic raceways from unshielded power conductors and electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum 5 inch (127 mm).
2) Power Rating between 2 and 5 kVA: Minimum 12 inch (300 mm).
3) Power Rating More Than 5 kVA: Minimum 24 inch (600 mm).

c. Separate communications cables in grounded metallic raceways from unshielded power lines or electrical equipment as follows:

1) Power Rating Less Than 2 kVA: Minimum 2-1/2 inch (64 mm).
2) Power Rating between 2 and 5 kVA: Minimum 6 inch (150 mm).
3) Power Rating More Than 5 kVA: Minimum 12 inch (300 mm).

d. Separate communications cables in grounded metallic raceways from power lines and electrical equipment located in grounded metallic conduits or enclosures as follows:

1) Power Rating Less Than 2 kVA: No minimum distance.
2) Power Rating between 2 and 5 kVA: Minimum 3 inch (76 mm).
3) Power Rating More Than 5 kVA: Minimum 6 inch (150 mm).

e. Separate communications cables from electrical motors and transformers rated 5 kVA or 5 HP and larger minimum 48 inch (1200 mm).
f. Separate communications cables from fluorescent luminaires minimum 5 inch (127 mm).

8. Identify system components, wiring, and cabling in accordance with TIA-606.

a. 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 must comply with TIA-606 for Class 3 level of administration and comply with client standard document AMKFM-224001.

9. Cable and Wire Identification:

a. Label each cable within 4 inch (100 mm) of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
b. Each wire connected to building-mounted devices is not required to be numbered at device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft (4.5 m).
d. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from panel or cabinet to building-mounted device, with name and number of particular device.
2) Label each unit and field within distribution racks and frames.

e. 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 different color for jacks and plugs of each service.

10. Cable Schedule: Install in 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 electronic copy of final comprehensive schedules for Project.
11. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
12. All labeling will comply with client standard document AMKFM-224001.

D. Interfaces with Other Work:

1. Entrance Facilities: Coordinate backbone cabling with Section 27 11 00 "Communications Equipment Room Fittings" for cabinets, racks, and protectors and demarcation point provided by communications service provider.
2. Coordinate with Section 07 84 13 "Penetration Firestopping" for sealing fire-rated penetrations.
3. Coordinate with Section 26 05 33.16 "Boxes and Covers for Electrical Systems" for installation of outlet boxes and cover plates.
4. Coordinate with Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding communications cabling and connectors.
5. Coordinate with Section 27 05 28 "Pathways for Communications Systems" for installation of provisions for routing and terminating cable assemblies.
6. Coordinate with Section 27 05 29 "Hangers and Supports for Communications Systems" for installation of cable supports.
7. Coordinate with Section 27 05 36 "Cable Trays for Communications Systems" for installation of cable trays.

3.3 FIELD QUALITY CONTROL OF COMMUNICATIONS COPPER BACKBONE CABLING

A. Acceptance Testing Preparation:

1. End –To-End Polarity Testing: A minimum of 99% pair functional connectivity shall be verified by end-to-end polarity testing. Polarity test shall verify correct tip, ring and pair.

2. TDR Test: Perform a Time Domain Reflectivity test to verify splices and correct gauge of wire throughout the run.
3. Documentation: Provide complete documentation of each test performed and printout of TDR test.
4. Contractor shall submit each test to AMP-400 for acceptance and approval by the FAA. AMP-400 shall provide test results to AMK-224 for review and approval. Contractor shall replace any defective or noncompliant cable at no additional cost to the FAA.

B. Field tests and inspections must be witnessed by authorities having jurisdiction.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Visually inspect jacket materials for 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-568.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Nonconforming Work:

1. Cable assemblies will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective cable assemblies and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 PROTECTION

A. After installation, protect cable assemblies and accessories from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 27 13 23

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type OFNR optical fiber cable.
2. Optical fiber cable hardware.

1.2 DEFINITIONS

A. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.

B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

C. Type OFCP: Conductive cable for use in plenums, ducts, and other spaces used for environmental air.

D. Type OFCR: Conductive cable for use as riser in vertical shafts or from floor to floor.

E. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.

F. Type OFNR: Nonconductive cable for use as riser in vertical shafts or from floor to floor.

G. Types OFC and OFCG: Conductive cable for general purpose use.

H. Types OFN and OFNG: Nonconductive cable for general purpose use.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Type OFNR optical fiber cable.
2. Optical fiber cable hardware.

B. Shop Drawings:

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.

2. Cabling administration drawings and printouts.
3. Wiring diagrams showing typical schematic arrangement, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Cross-connects.
f. Patch panels.
g. Patch cords.

4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates: For each type of product.

D. Field Quality-Control Reports: Optical fiber cable testing plan.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software service agreement.

B. Maintenance Data: For optical fiber cable, splices, and connectors.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish to Owner extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Patch-Panel Units: One of each type.
2. Plugs: 10 of each type.
3. Jacks: 10 of each type.

1.7 DELIVERY, STORAGE, AND HANDLING

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 remainder of construction period.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.1 TYPE OFNR OPTICAL FIBER CABLE

A. Type OFNR Optical Fiber Cable: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Type OFNR, Designation OM4, Multimode Optical Fiber Cable:

1. FREEDM Loose Tube, Gel-Free Cable, Riser 12 F, 50 µm multimode (OM4) model number 012TUF-T4190D20.
2. Source Limitations: Obtain products from single manufacturer.
3. Additional Characteristics:

a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.

4. Options:

    a. Configuration: 12-fiber, tight buffer, optical fiber cable.
    b. Maximum Attenuation: 3.0 dB/km at 850 nm wavelength; 1.0 dB/km at 1300 nm wavelength.
    c. Jacket Color: Aqua.

D. Type OFNR, Designation OS2, Inside-Outside Plant, Single-Mode Optical Fiber Cable:

1. MiniXtend Cable with Binderless FastAccess Technology 12 F, SMF-28® Ultra fiber, Single-mode model number 012ZM4-T4F22A20.
2. Source Limitations: Obtain products from single manufacturer.
3. Additional Characteristics:

    a. Construction: TIA-492CAAB; 9 µm core diameter, 125 µm cladding diameter, with low water peak.
    b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

4. Options:

    a. Configuration:

        1) 12-fiber, single loose tube, optical fiber cable.

    b. Maximum Attenuation: 0.34 dB/km at 1310 nm wavelength; 0.22 dB/km at 1550 nm wavelength.
    c. Jacket Color: Yellow.

2.2 OPTICAL FIBER CABLE HARDWARE

A. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36 inch lengths.

D. Connector Type: Type LC complying with TIA-604-10 connectors.

E. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.5 dB.
3. UniCam Connectors LC, 50 µm Multimode (OM4), Black model number 95-050-99-X
4. UniCam® Connectors LC, Single-mode (OS2), Blue model number 95-200-99

2.3 SOURCE QUALITY CONTROL

A. Testing Administrant: Engage qualified testing agency to evaluate cables.

B. Factory Tests and Inspections:

1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
2. Test and inspect pre-terminated optical fiber cable assemblies, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

C. Nonconforming Work:

1. Cables that do not pass tests and inspections will be considered defective.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 SELECTION OF OPTICAL FIBER TYPE

A. Installed in Vertical Shaft or Floor-to-Floor Riser:

1. Nonconductive:

a. Type OFNR.

B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:

1. Nonconductive:

a. Type OFNR in metallic conduit.

C. Installed in Location Other Than Riser or Plenum:

1. Nonconductive: Type OFNR in metallic conduit.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:

a. Comply with requirements for pathways specified in Section 27 05 28 "Pathways for Communications Systems."

2. In 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.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
9. In communications equipment room, provide 10 ft long service loop on each end of cable.

10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Installation of Cable Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after flooring system has been installed in raised floor areas.
3. Coil cable 6 ft long not less than 12 inch in diameter below each feed point.

J. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Administration Class: Class 3.
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 must comply with TIA-606 for Class 3 level of administration.

C. Comply with requirements in Section 27 15 23 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.

D. Cable Schedule: Install in 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 electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

F. Cable and Wire Identification:

1. Label each cable within 4 inch of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

G. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Installed cable shall be tested and pass the inventory and acceptance testing specified in FAA standard AMKFM-224001. The tests and inspections shall be witnessed by the contractor’s resident project representative.

2. Fiber optic testing shall be performed in accordance with FAA standard AMKFM-224001 for acceptance tests and measurements of telephone plant.

B. Field tests and inspections must be witnessed by authorities having jurisdiction.

C. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory 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-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:
    1) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

D. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

E. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.
2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

END OF SECTION

SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6a twisted pair cable.
2. Twisted pair cable hardware.
3. Cable management system.
4. Identification products.

B. Related Requirements:

1. Section 27 05 13 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

2. Additional requirements from the owner are provided in document AMKFM-22 40 01.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Category 6a twisted pair cable.
2. Twisted pair cable hardware.
3. Cable management system.
4. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.

2. Cabling administration Drawings and printouts.
3. 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. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 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. Cover Plates: One of each type.
3. Jacks: Ten of each type.
4. Patch-Panel Units: One of each type.
5. Plugs: Ten of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 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.

1.10 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.

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. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. 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:

a. Type CMP complying with UL 1685 or Type CMP in listed cable routing assembly.
b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2. Communications, Non-Plenum Rated:

a. 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 E84; 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. Category 6 Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 500 MHz.

B. BERK-TEK #10136339

C. Standard: Comply with TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP) CMR.

F. Cable Rating: Riser.

G. Jacket: Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of 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.
4. Female 8P8C connectors shall be orange with the part number MGS400BH-112.

C. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.

c. 24 Port Patchmax CAT6 #760102251 or 48 Port Patchmax CAT6 #760128207.

2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

D. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) and 48-inch (1200-mm) 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.

E. 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.

F. 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 cover plate.
3. Standard: Comply with TIA-568-C.2.

G. Cover Plate:

1. Four port, vertical single gang cover plates designed to mount to single gang wall boxes.
2. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 26 05 33.16 "Boxes and Covers for Electrical Systems."
3. For use with M106 Flush mounted modular mounting frame, four port ivory part number #106622277 and two twisted pair work area cords with two blanks per outlet.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

H. Legend:

1. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA-568-C.1.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Routing:

a. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. 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 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 (12 mm) 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. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:

a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.

b. Locate consolidation points for twisted pair cables at least 49 feet (15 m) from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. 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.
11. 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.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
14. 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 (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. 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 (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

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 (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

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 (76 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.4 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Administration Class: Class 3.
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, including optional identification requirements of this standard.

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 4 inches (100 mm) 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. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with 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.

3.6 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Acceptance tests and procedures shall be developed by the telecommunications subcontractor in accordance with the provisions of this specification and accepted by the FAA. The telecommunications subcontractor shall test the installed systems in accordance with the accepted test procedures.

B. Field tests and inspections must be witnessed by authorities having jurisdiction.

C. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's

"Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

E. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION

SECTION 27 51 16

PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Section 27 00 10 "Supplemental Requirements for Communications" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

B. Section 07 84 13 "Penetration Firestopping" specifies firestopping for communications pathways installed by this Section.

C. Section 26 05 26 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding conductors and connectors for communications pathways installed by this Section.

1.2 SUMMARY

A. Section Includes:

1. Power amplifiers.
2. Transfer to standby amplifier.
3. Telephone paging adapter.
4. Loudspeakers.
5. Conductors and cables.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Power, signal, and control wiring.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
3. Console layouts.
4. Control panels.
5. Rack arrangements.
6. Calculations: For sizing backup battery.
7. Wiring Diagrams: For power, signal, and control wiring.

    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

C. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components 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 supports and seismic restraints for control consoles, equipment cabinets and racks, and components.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For Installer.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For public address systems to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 77 00 "Closeout Procedures" and Section 01 78 23 "Operation and Maintenance Data," include the following:

    a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    b. Operating instructions laminated and mounted adjacent to operating console location.
    c. Training plan.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Personnel certified by NICET as Audio Systems Level III Technician.

B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.

1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain public address system from single source from single manufacturer.

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

C. Comply with NFPA 70.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:

1. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
2. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components shall withstand the effects of earthquake motions determined according to Seismic Design Category C.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 SYSTEM DESCRIPTION

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with EIA/ECA-310-E.

2.5 POWER AMPLIFIERS

A. Bogen Platinum Series Public Address Amplifiers model PS600

B. Mounting: Rack model GSDRPK.

C. Output Power: 70-V balanced line. for each station and speaker connected in all-call mode of operation, plus a 25 percent allowance for future stations.

D. Total Harmonic Distortion: Less than 3 percent at rated power output from 20 to 20,000 Hz.

E. Minimum Signal-to-Noise Ratio: -70 dB or better.

F. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.

G. Output Regulation: Less than 2 dB from full to no load.

2.6 TELEPHONE PAGING ADAPTER

A. Telephone access module type Bogen Model number TAMB2PS.

B. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.

1. Minimum Frequency Response: Flat, 200 to 8000 Hz at plus or minus 1 dB.
2. Impedance Matching: Adapter matches telephone line to public address equipment input.
3. Cabinet mounted.

2.7 LOUDSPEAKERS

A. Cone-Type Loudspeakers:

1. 8” preassembled speaker package Model SD72W or Valcom model V-1420
2. Minimum Axial Sensitivity: 97 dB average.
3. Frequency Response: Within plus or minus 5 dB from 55 to 19,000 Hz.
4. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
5. Minimum Dispersion Angle: 105 degrees.
6. Matching Transformer: Full-power rated with five taps. Maximum insertion loss of 0.5 dB.
7. Flush-Ceiling-Mounted Units: In back boxes model CS95-8.
8. Unidirectional and Bi-directional surface baffles for 8” loudspeakers model 410-8(W)*.
9. 81 Series Tile Bridges for 8” loudspeakers model 81-8SA.

2.8 BATTERY BACKUP POWER UNIT

A. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.

B. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.

C. Battery shall be on float charge when not supplying system and able to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.

D. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

2.9 CONDUCTORS AND CABLES

A. 16 AWG copper conductor, 300 volt insulation, rated 60 degrees C, paired conductors twisted together shielded and covered with a PVC jacket, model West Penn 245

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method:

1. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathway and cables except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for pathways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."
c. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure for ceiling suspension system. Include bridle rings or drive rings.

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. 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.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. 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.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and

adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by equipment manufacturer.

3.3 INSTALLATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

C. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

D. Equipment Cabinets and Racks:

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

E. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

F. Wall-Mounted Outlets: Flush mounted.

G. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

H. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

I. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

J. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

K. Connect wiring according to Section 27 15 00 "Communications Horizontal Cabling" and Section 28 05 13 "Conductors and Cables for Electronic Safety and Security."

3.4 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Section 27 05 26 "Grounding and Bonding for Communications Systems."

C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

D. Public address system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION

SECTION 28 00 10

SUPPLEMENTAL REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Supplemental requirements generally applicable to the Work specified in Division 28.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for abbreviations and acronyms for electrical terms and units of measure, abbreviations and acronyms for electrical raceway types, abbreviations and acronyms for electrical cable types, and additional coordination drawing submittal requirements.
2. Section 26 00 11 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.3 REFERENCES

A. Abbreviations and Acronyms for Electronic Safety and Security:

1. BMS: Building management system.
2. FACU: Fire-alarm control unit.
3. POTS: Plain old telephone service. See "public switched telephone network."

B. Definitions for Electronic Safety and Security:

1. Calling Party Control (CPC): A momentary break in phone line loop current, which is used to signal voicemail and other automated telephone company services that distant party has hung up.
2. Private Branch Exchange (PBX): Analog telephone switch that routes calls internal to a business or organization so a direct external line for each phone is unnecessary.

3. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted-pair cables from a telephone-provider central office for the transmission medium. PSTN refers to the telephone network; POTS refers to the individual subscriber line.
4. Remote Office Phone System (ROPS): VoIP system that allows phones for a business or organization located anywhere in the world with internet connectivity to behave similar to phones connected to a PBX.
5. Ringer Equivalence Number (REN): The loading effect of a single traditional telephone ringing circuit. TIA-968 defines REN 1 as an impedance of 7000 Ω at 20 Hz (Type A ringer) or 8000 Ω from 15 Hz to 68 Hz (Type B ringer). The sum of the RENs for all devices on a subscriber line circuit may not exceed the maximum permitted REN for the subscriber line.
6. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.

1.4 ACTION SUBMITTALS

A. Coordination Drawings: Submit multidiscipline coordination drawings depicting electronic safety and security equipment, devices, cabling, conduit, and duct banks in accordance with requirements specified in Section 26 00 10 "Supplemental Requirements for Electrical."

1.5 INFORMATIONAL SUBMITTALS

A. Installation Schedule for Security, Fire Alarm, and Other Life Safety Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of security, fire alarm, and other life safety Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of specified coordination drawings.
2. Submission of action submittals specified in Division 28.
3. Closing of walls and ceilings containing security and fire-alarm Work.
4. System startup, testing, and commissioning activities for security and fire-alarm equipment.
5. System startup, testing, and commissioning activities for fire-alarm interfaces with Work specified in other divisions.
6. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
7. Requests for inspections by authorities having jurisdiction.

B. Qualification Statements:

1. For qualified regional manufacturer.
2. For fire-alarm cable Installer.
3. For fire-alarm testing agency and on-site fire-alarm testing supervisor.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device listed below:

2. Include the following information:

a. Manufacturer's operating specifications.
b. User's guides for software and hardware.
c. Schedule of maintenance material items recommended to be stored at Project site.
d. Detailed instructions covering operation under both normal and abnormal conditions.
e. Manufacturer's instructions for setting field-adjustable components.
f. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.
6. For lighting controls, include the following:

a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
b. Operation of adjustable zone controls.

C. Software:

1. Provide to Owner upgrades and unrestricted licenses for Government use for installed and backup software, including operating systems and programming tools required for operation and maintenance.

1.7 QUALIFICATIONS

A. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 01 40 00 "Quality Requirements," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.

B. Security Cable Installer: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate electronic security cabling.

C. Fire-Alarm Cable Installer: Entity possessing active qualifications specified in Section 01 40 00 "Quality Requirements" with training and manufacturer certification to install, splice, and terminate fire-alarm cabling.

D. Fire-Alarm Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site fire-alarm testing supervisor must have NICET Level III certification and documented training, or be qualified life safety professional engineer, and be experienced with testing fire-alarm equipment in accordance with NFPA 72 testing standards.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRONIC SAFETY AND SECURITY EQUIPMENT

A. Substitution requests for electronic safety and security equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electronic Safety and Security Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Electronic Safety and Security Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRONIC SAFETY AND SECURITY WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' instructions, comply with NFPA 70, NFPA 72, NFPA 731, and NECA NEIS 1 for installation of Work specified in Division 28. Consult Architect for resolution of conflicting requirements.

3.2 FIELD QUALITY CONTROL

A. Administrant for Fire-Alarm Tests and Inspections:
1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

2. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Administrant for Security Tests and Inspections:
1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
2. Administer and perform tests and inspections with assistance of factory-authorized service representative.

3.3 CLOSEOUT ACTIVITIES

A. Demonstration:

1. Demonstrate to Owner's maintenance and clerical personnel and building occupants how to operate the following systems and equipment:

a. Provide instructional video demonstrating operation by building occupants of system specified in Section 28 10 00 "Access Control."
b. Provide instructional video demonstrating operation by building occupants of system specified in Section 28 16 00 "Intrusion Detection."
c. Provide instructional video demonstrating operation by building occupants of system specified in Section 28 20 00 "Video Surveillance."
d. Provide instructional video demonstrating operation by building occupants of system specified in Section 28 31 11 "Digital Addressable Fire Alarm System."

B. Training:

1. Train Owner's maintenance personnel on the following topics:
a. How to adjust, operate, and maintain FACUs, their battery backup, graphic annunciators, and remote annunciators specified in Section 28 46 21.11 "Addressable Fire-Alarm Systems."

END OF SECTION

SECTION 28 05 13

CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balanced twisted-pair cabling.
2. Fire alarm wire and cable.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. IDC: Insulation displacement connector.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Installation data for cables as specified in TIA 569-D.

B. Shop Drawings:

1. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of Technician.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

B. Testing Agency Qualifications: Certified by BICSI.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of paired cables for open and short circuits.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

D. 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: 450 or less.

E. RoHS compliant.

2.2 CATEGORY 6 BALANCED 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. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685.
2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
3. Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.
4. Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.
5. 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."

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Shielded twisted pairs (FTP).

E. Cable Rating: Plenum.

F. Jacket: White, Gray, Blue, or Yellow thermoplastic.

G. Connecting Blocks:

1. 110-style IDC for Category 5e.
2. 66-style IDC for Category 5e.
3. 110-style IDC for Category 6.
4. 110-style IDC for Category 6a.
5. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

H. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

I. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.

c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.

3. Number of Jacks per Field: One for each four-pair cable indicated.

J. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) 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.

K. Plugs and Plug Assemblies:
1. Standard: Comply with TIA-568-C.2.

2. Marked to indicate transmission performance.

L. 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.

M. Faceplate:

1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Eight port, vertical double gang faceplates designed to mount to double gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
4. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

N. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.3 FIRE ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated.

2.4 CONSOLIDATION POINTS

A. Description: Consolidation points shall comply with requirements for cable connecting hardware.

1. Number of Terminals per Field: One for each conductor in assigned cables.

2. Number of Connectors per Field:

a. One for each balanced twisted-pair cable indicated.
b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.

3. Mounting: Recessed in ceiling, or wall.
4. NRTL listed as complying with UL 50 and UL 1863.
5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.5 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 27 05 53 "Identification for Communications Systems."

C. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

D. Comply with TIA-607-B.

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Install wiring in metal pathways and wireways.

1. Minimum conduit size shall be 3/4 inch. Control and data-transmission wiring shall not share conduits with other building wiring systems.
2. Comply with requirements in Section 27 05 28.29 "Hangers and Supports for Communications Systems."
3. Comply with requirements in Section 26 05 36 "Cable Trays for Electrical Systems."
4. Comply with requirements in Section 27 05 36 "Cable Trays for Communications Systems."

B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring on Racks and within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.
3. Install lacing bars and distribution spools.
4. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
5. Install conductors parallel with or at right angles to sides and back of enclosure.
6. Connect conductors associated with intrusion system that are terminated, spliced, or interrupted in any enclosure onto terminal blocks.
7. Mark each terminal according to system's wiring diagrams.
8. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.2 GENERAL REQUIREMENTS FOR INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1, NFPA 70, and TIA-568-C.1.

B. Comply with Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

C. Comply with requirements in Section 27 05 28.29 "Hangers and Supports for Communications Systems" for cable support installation.

D. Comply with BICSI Information Technology Systems Installation Methods Manual for installation of equipment in communications equipment spaces.

E. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

F. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

G. Install balanced twisted-pair, optical-fiber, and coaxial cables and connecting materials after spaces are complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

H. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels. Leave a minimum of 6 inches (150 mm) of slack at outlet terminations and coil loosely into box after termination on outlet fitting.

I. 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.

J. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

K. Pulling Cable: Monitor cable pull tensions. Do not exceed manufacturer's rated cable-pulling tension.

L. Riser Cable: Riser cable support intervals shall be in accordance with manufacturer's recommendations.

M. Separation from EMI Sources:

1. Comply with BICSI Telecommunications Distribution Methods Manual and TIA-569-D recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communication cables or cables in nonmetallic pathways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communication cables in grounded metallic pathways 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 (64 mm).
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between cables in grounded metallic pathways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or hp and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Luminaires: A minimum of 5 inches (127 mm).

3.3 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 27 05 28.29 "Hangers and Supports for Communications Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and pathways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of two-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or pathway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and another for supervisory circuits. Color code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.4 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.5 CONNECTIONS

A. Comply with requirements in Section 28 16 43 "Perimeter Security Systems" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Section 28 16 00 "Intrusion Detection" for connecting, terminating, and identifying wires and cables.

C. Comply with requirements in Section 28 13 00 "Access Control" for connecting, terminating, and identifying wires and cables.

D. Comply with requirements in Section 28 23 00 "Video Surveillance" for connecting, terminating, and identifying wires and cables.

E. Comply with requirements in Section 28 31 11 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D.

C. Comply with BICSI Information Technology Systems Installation Methods Manual.

3.7 GROUNDING

A. For communication wiring, comply with TIA-607-B and with BICSI Telecommunications Distribution Methods Manual "Bonding and Grounding (Earthing)" chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 27 05 26 "Grounding and Bonding for Electronic Safety and Security."

3.8 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect balanced twisted-pair and optical-fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color coding for pin assignments, and inspect cabling connections to confirm 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.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 28 05 26

GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.

1.3 DEFINITIONS

A. Signal Ground: The ground reference point designated by manufacturer of the system that is considered to have zero voltage.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Comply with UL 486A-486B.

2.2 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

1. 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.
2. Bond shields and drain conductors to ground at only one point in each circuit.

B. Comply with NECA 1.

3.2 APPLICATION

A. Conductors: Install solid conductor for No. 8 > AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.

3.3 CONNECTIONS

A. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

B. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

C. Shielded Cable: Bond the shield of shielded cable to the signal ground. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

D. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 28 10 00

ACCESS CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access control system.

B. Related Requirements:

1. Section 26 00 11 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
2. Section 28 00 10 "Supplemental Requirements for Electronic Safety and Security" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
3. Section 08 71 00 "Door Hardware" specifies the following:

    a. Card reader(s).
    b. Electrically controlled single-point latch(es).
    c. REX motion sensor(s).

1.2 DEFINITIONS

A. DGP: Data gathering panel.

B. NFC: Near field communications.

C. REX: Request-to-exit.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. Project general notes.
2. Head-end hardware, equipment, and device locations.
3. Block diagram and cable/conduit routing illustrating end-to-end system wiring.
4. End-to-end system communications details.
5. Secondary power calculations

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Installation and programming instructions for operating system software, including all applicable software add-ons.
2. Installation and programming instructions for antivirus and security protection software.
3. Manufacturer's recommended setup and testing procedure for operating system software and applicable software add-ons.
4. Troubleshooting instructions for operating system software and applicable software add-ons.
5. Manufacturer's recommended setup and testing procedure for antivirus and security protection software.
6. Troubleshooting instructions for antivirus and security protection software.
7. Installation instructions for access control system servers.
8. Installation instructions for access control system input/output interface.
9. Installation instructions for access control system door controllers.
10. Manufacturer's recommended testing and inspection procedure for operation of access control system servers, panels, input/output interfaces, door controllers, and workstations.
11. Manufacturer's recommended testing and inspection procedure for operation of access control system power supplies and battery chargers.
12. Manufacturer's recommended testing and inspection procedure for operation of access control system printers.
13. Installation instructions for integrated credential readers and entry management devices.
14. Printing, programming, and handling instructions for access control credentials.
15. Installation instructions for electrified locking devices and accessories.
16. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
17. Manufacturer's recommended tests and inspections for egress management devices.
18. Manufacturer's recommended testing and inspection procedure for end-to-end operation of access control system software, hardware, and integrated hardware devices.

B. Warranty documentation.

1.6 REGULATORY AGENCY APPROVALS

A. Submittals for access control system requiring approval by authorities having jurisdiction must be signed and sealed by qualified life safety professional engineer

responsible for their preparation. Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.

B. Submittals for access control system require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.7 WARRANTY FOR ACCESS CONTROL SYSTEM

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed access control system performs in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

1.8 WARRANTY FOR BATTERIES

A. Special Manufacturer Extended Warranty for Batteries: Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within warranted cycle life.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM

A. Description: Access control system provides a means of regulating or controlling physical entry into an area, or access to or use of a device by electrical, electronic, and/or mechanical means. Typical access control system includes a card reader at a controlled door, which reads a user credential and sends the collected data to a centrally located DGP over the cabling infrastructure. DGP may hold a user database onboard or may communicate with a user database over the network. If user is authorized for access at a controlled door, DGP signals the electronic lock at the door to unlock. If user credential is not authorized according to user database, the door remains locked and access is denied. In addition to card readers and electronic locks, access control systems may include various other connected devices programmed for a desired function.

B. Performance Criteria:

1. Regulatory Requirements:

a. Components listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.
c. Certification: Provide certificate, authorized under UL Certification Service, that access control system installation complies with installation requirements of UL CCN ALOV.

2. Listing Criteria: UL CCN ALOV and UL CCN ALVY; including UL 294.
3. Consult Architect for resolution of conflicting requirements.

C. Selection of Access Control System Components:

1. Source Limitations: Obtain components for access control system from sources approved by manufacturer warranting performance of entire system.
2. Provide the following specified products with the access control system:

a. Access Control Software and Database Management:

1) Access control system unit operating system software.
2) Access control system unit antivirus and security protection software.

b. Access Control System Hardware:

1) Access control system door controller(s).
2) Access control system input/output interface(s).
3) Access control system power supply and battery charger(s).

c. Security Door Hardware:

1) Electric strike(s).
2) Exit lock(s) and Alarm(s).

d. Integrated Credential Readers and Entry Management:

1) Chip card reader(s).

e. Access Control Credentials:

1) Access control cards as specified by owner.

f. Electrified Locking Devices and Accessories:

1) Electrically controlled single-point latch(es).
2) Insert quantity REX motion sensor(s).

D. Special Techniques:

1. Comply with manufacturer's published instructions.
2. Mounting Heights: Mount field devices in accessible locations in accordance with United States Access Board ADA-ABA Accessibility Guidelines standards.
3. Wiring Methods:

a. Backbone Cable Type: copper.
b. Cable Type: Shielded.
c. Analog Maximum Cable Length: 1000 ft.
d. Digital Maximum Cable Length: 300 ft.

E. Interfaces with Other Work:

1. Coordinate installation of new access control system components with existing conditions.

2. Coordinate with Section 08 71 00 "Door Hardware" for interfacing access control system devices with door hardware.
3. Coordinate with Section 28 31 11 "Addressable Fire-Alarm Systems" for unlocking secured doors that are in exit ways, with or without delay.

F. Systems Integration:

1. Coordinate with Section 28 16 00 "Intrusion Detection" for integrating access control system with intrusion detection system.
2. Coordinate with Section 28 20 00 "Video Surveillance" for integrating access control system with video surveillance controls.

3.2 FIELD QUALITY CONTROL OF ACCESS CONTROL SYSTEM COMPONENTS

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections for access control system components.
2. Perform industry standard tests and inspections for power supplies, batteries, and other standby power provisions.
3. Engage factory-authorized service representative to test end-to-end system connection and functionality.
4. Verify monitoring of access control system status and diagnostics information.

C. Nonconforming Work:

1. Access control equipment will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports.

3.3 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.

3.4 ADJUSTING

A. Control Sensor Adjustments: Adjust control devices to suit actual occupied conditions.

1. For proximity motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.5 PROTECTION

A. After installation, protect access control system components from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.6 MAINTENANCE

A. Control Sensor Readjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in readjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION

SECTION 28 16 00

INTRUSION DETECTION

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. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
2. Integration of other electronic and electrical systems and equipment.

B. Related Sections:

1. Section 27 13 13 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.
2. Section 27 13 23 "Communications Optical Fiber Backbone Cabling" for multi- and single-mode backbone (riser-rated) optical fiber.
3. Section 27 15 13 "Communications Copper Horizontal Cabling" for Category 5e, 6, and 7 horizontal (general use, riser-, and plenum-rated) cabling.
4. Section 28 05 13 "Conductors and Cables for Electronic Safety and Security" for cabling between master control units and field-mounted devices and control units.

1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. PIR: Passive infrared.

C. RFI: Radio-frequency interference.

D. UPS: Uninterruptible power supply.

E. Control Unit: System component that monitors inputs and controls outputs through various circuits.

F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the

number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

I. Standard Intruder: A person who weighs 100 lb or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.

J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 ACTION SUBMITTALS

A. Product Data: Components for sensing, detecting, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers and control interface devices and media to be used. Describe characteristics of network and other data communication lines.

    a. Indicate methods used to achieve systems integration.
    b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
    c. Describe characteristics of network and other data communication lines.
    d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

2. UPS: Sizing calculations.

3. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
4. Master Control-Unit Console Layout: Show required artwork and device identification.

5. Device Address List: Coordinate with final system programming.
6. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
7. Details of surge-protection devices and their installation.
8. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For intrusion detection systems integrator.

B. Field quality-control reports.

1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

C. Product Warranty: Sample of special warranty.

D. Field Test Reports: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.

E. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
4. Installation Supervision: Installation shall be under the direct supervision of Level 2 Commercial Installer, who shall be present at all times when Work of this Section is performed at Project site.

5. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

1. At least one of whom is a Certified Systems Integrator.

C. Testing Agency Qualifications: Certified by BICSI.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.8 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except master control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Comply

with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph.

4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Description: Hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Supervision: System components shall be continuously monitored for normal, alarm, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

D. System Control: Master control unit shall directly monitor intrusion detection devices and connecting wiring in a multiplexed distributed control system or as part of a network.

E. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

F. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
5. Protected Zone Test: Initiate operational test of a specific protected zone.
6. System Test: Initiate system-wide operational test.
7. Print reports.

G. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

H. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:

1. Switch selected lights.
2. Shift elevator control to a different mode.
3. Open a signal path between certain intercommunication stations.
4. Shift sound system to "listening mode" and open a signal path to certain system speakers.
5. Switch signal to selected monitor from CCTV camera in vicinity of sensor signaling an alarm.

I. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

J. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

K. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

L. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and

weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

M. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.2 SYSTEM COMPONENT 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. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

C. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.

D. Comply with NFPA 70.

E. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:

1. Door hardware specified in Section 08 71 00 "Door Hardware."
2. Access control system specified in Section 28 10 00 "Access Control."
3. Video surveillance system specified in Section 28 20 00 "Video Surveillance."

F. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

G. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

H. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

I. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

J. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

DOOR AND WINDOW SWITCHES

K. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

L. Flush-Mounted Switches: Unobtrusive and flush with surface of door.

M. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

2.3 PIR SENSORS

A. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

B. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.

1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet.
2. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree conical.
3. Ceiling-Mounted Unit Pattern Size: 84-inch diameter at floor level for units mounted 96 inches above floor; 18-foot diameter at floor level for units mounted 25 feet above floor.

C. Device Performance:

1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.

3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.4 MASTER CONTROL UNIT

A. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Addressable initiation devices that communicate device identity and status.

4. Control circuits for operation of mechanical equipment in response to an alarm.

B. Construction: Freestanding equipment rack, modular, with separate and independent alarm and supervisory system modules. Arrangements that require removal of field wiring for module replacement are unacceptable.

C. Comply with UL 609.

D. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
2. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.

3. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

    a. Acknowledge alarm.
    b. Silence alarm.
    c. System reset.
    d. LED test.

4. Timing Unit: Solid state, programmable, 365 days.
5. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status.

Software shall interpret such signals, display equipment status, and initiate failure signals.

6. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the addressable detector originating the alarm.

7. Alarm activation sounds a bell or siren and strobe.

E. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

F. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

G. UPS: Comply with Section 26 33 53 "Static Uninterruptible Power Supply." UPS shall be sized to provide a minimum of six hours of master control-unit operation.

H. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify, with permanent labels, individual components and modules within cabinets.

I. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

J. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

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

3.2 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:

1. Electronic door hardware.
2. Access control.

3.3 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 27 05 48.16 "Seismic Controls for Communications Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 27 0548.16 "Seismic Controls for Communications Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

3.4 WIRING INSTALLATION

A. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited

conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120-V Power Wiring: Install according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 28 05 13 "Conductors and Cables for Electronic Safety and Security."

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

F. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 27 05 53 "Identification for Communications Systems."

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 27 05 53 "Identification for Communications Systems."

B. Install instructions frame in a location visible from master control unit.

3.6 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems."

3.7 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

F. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

G. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION

SECTION 28 20 00

VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.

B. Related Requirements:

1. Section 28 05 26 "Grounding and Bonding for Electronic Safety and Security"

1.3 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. WAN: Wide area network.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

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

B. 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.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for cameras, camera-supporting equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Product Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h). Use NEMA 250, Type 4X enclosures.
2. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.

1.8 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 SYSTEM REQUIREMENTS

A. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to Seismic Design Category C.

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."

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 NECA 1.

D. Comply with NFPA 70.

2.3 STANDARD CAMERAS

A. Color Camera:

1. Pickup Device: CCD interline transfer, 380,000 771(H) by 492(V) pixels.
2. Horizontal Resolution: 480 lines.
3. Signal-to-Noise Ratio: Not less than 50 dB
4. Sensitivity: Camera shall comply with ONVIF standards
5. Motion Detector: Built-in digital.

2.4 LENSES

A. Description: Optical-quality coated lens, designed specifically for video-surveillance applications and matched to specified camera. Provide color-corrected lenses with color cameras.

1. Auto-Iris Lens: Electrically controlled iris with circuit set to maintain a constant video level in varying lighting conditions.
2. Fixed Lens: With calibrated focus ring.

2.5 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera, infrared illuminator, and lens.

1. Enclosure: NEMA 250, Type 4X.

2.6 INFRARED ILLUMINATORS

A. Description: Lighting fixtures that emit light only in the infrared spectrum, suitable for use with cameras indicated, for nighttime surveillance, without emitting visible light.

1. Field-Selectable Beam Patterns: Narrow, medium, and wide.
2. Rated Lamp Life: More than 8000 hours.
3. Power Supply: 12-V ac/dc.

B. Area Coverage: Illumination to 150 feet (50 m) in a narrow beam pattern.

C. Exterior housings shall be suitable for same environmental conditions as the associated camera.

2.7 CAMERA-SUPPORTING EQUIPMENT

A. Minimum Load Rating: Rated for load in excess of the total weight supported times a minimum safety factor of two.

B. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions.

C. Protective Housings for Fixed and Movable Cameras: Steel 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. Camera Viewing Window: Polycarbonate window, aligned with camera lens.
2. Duplex Receptacle: Internally mounted.
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. Sun shield shall not interfere with normal airflow around the housing.
5. 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.
6. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.

2.8 NETWORK VIDEO RECORDERS

A. External storage or internal 250-1, 500-GB hard disk drive.

1. Video and audio recording over TCP/IP network.
2. Video recording of MPEG-2 and MPEG-4 streams.
3. Video recording up to 48 Mbps for internal storage and up to 100 Mbps for external storage.
4. Duplex Operation: Simultaneous recording and playback.
5. Continuous and alarm-based recording.
6. Full-Featured Search Capabilities: Search based on camera, time, or date.

7. Automatic data replenishment to ensure recording even if network is down.
8. Digital certification by watermarking.
9. Internal RAID storage or non-RAID storage of up to 1500 GB.
10. Capable of adding external RAID storage up to 7000 GB for models with no internal storage.
11. Full integration with LAN, Intranet, or Internet through standard Web browser or video management software.
12. Integrated Web server FTP server functionality.
13. Supports up to 16 devices.

2.9 IP VIDEO SYSTEMS

A. Description:

1. System shall provide high-quality delivery and processing of IP-based video, audio, and control data using standard Ethernet-based networks.
2. System shall have seamless integration of all video surveillance and control functions.
3. Graphical user interface software shall manage all IP-based video matrix switching and camera control functions, two-way audio communication, alarm monitoring and control, and recording and archive/retrieval management. IP system shall also be capable of integrating into larger system environments.
4. System design shall include all necessary compression software for high-performance, dual-stream, MPEG-2/MPEG-4 video. Unit shall provide connections for all video cameras, camera PTZ control data, bidirectional audio, discreet sensor inputs, and control system outputs.
5. All camera signals shall be compressed, encoded, and delivered onto the network for processing and control by the IP video-management software.
6. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
7. Encoder/decoder combinations shall place video, audio, and data network stream that can be managed from multiple workstations on the user's LAN or WAN.
8. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.

2.10 CONTROL STATIONS

A. Equipment Mounting: Standard 19-inch (483-mm) rack complying with CEA 310-E.

B. Normal System Power Supply: 120 V, 60 Hz, through a locked disconnect device and an isolation transformer in central-station control unit. Central-station control unit shall supply power to all components connected to it unless otherwise indicated.

C. Power Continuity for Control Station: Batteries in power supplies of central-station control units and individual system components shall maintain continuous system operation during outages of both normal and backup ac system supply.

1. Batteries: Rechargeable, valve-regulated, recombinant, sealed, lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portions of system served including audible trouble signal devices for up to four hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger shall recharge fully discharged battery within 24 hours.

D. Annunciation: Indicate change in system condition and switching of system or component to backup power.

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 27 05 28 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. For communication wiring, comply with the following:

1. Section 27 13 13 "Communications Copper Backbone Cabling."
2. Section 27 13 23 "Communications Optical Fiber Backbone Cabling."
3. Section 27 15 13 "Communications Copper Horizontal Cabling."

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Avoid ground loops by making ground connections only at the control station.

1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.

D. Identify system components, wiring, cabling, and terminals according to Section 27 05 53 "Identification for Communications Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. 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 (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
    e. Set and name all preset positions; consult Owner's personnel.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

D. Video surveillance system will be considered defective if it does not pass tests and inspections.

E. 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. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION

SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Notification appliances.
5. Device guards.
6. Remote annunciator.
7. Addressable interface device.
8. Digital alarm communicator transmitter.
9. Network communications.

B. Related Requirements:

1. Section 28 05 13 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

F. VESDA: Very Early Smoke-Detection Apparatus.

1.4 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 floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. 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.
    c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.6 Sample Warranty: For special warranty.

1.7 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 01 78 23 "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.

1.8 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. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Smoke Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
3. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
4. Keys and Tools: One extra set for access to locked or tamper proofed components.
5. Audible and Visual Notification Appliances: two of each type installed.
6. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by the manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

1.10 PROJECT CONDITIONS

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 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 Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. 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: Johnson Controls Inc.

B. Noncoded, addressable system, with multiplexed signal transmission and 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 initiation shall be by one or more of the following devices:

1. Manual stations.
2. Smoke detectors.
3. Water flow device.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances
2. Identify alarm and specific initiating device at fire-alarm control unit
3. Transmit an alarm signal to the remote alarm receiving station.
4. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.

4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Record the event on system printer.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Transmit system status to building management system.
5. Display system status on graphic annunciator.

2.3 FIRE-ALARM CONTROL UNIT

A. 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. 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.

B. 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. Display: Liquid-crystal type, 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

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. Display: Liquid-crystal type, two line(s) of 80 characters, minimum.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. 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.

F. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Notification appliances shall provide signals 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.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals supervisory and digital alarm communicator transmitters 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.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

2.4 MANUAL FIRE-ALARM BOXES

A. 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.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Double-action mechanism requiring two actions to initiate an alarm, with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
3. Station Reset: Key.
4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. 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.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
    a. Multiple levels of detection sensitivity for each sensor.
    b. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:

1. 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.
2. 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 average value.
    d. Present sensitivity selected.

e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:

1. 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.
2. 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 average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

2.6 NOTIFICATION APPLIANCES

A. 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.

1. 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.

B. 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.

C. 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.

1. Rated Light Output:

a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.

3. For ceiling mounting, where there is no finished ceiling, install on all thread to back of junction box.
4. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
5. Flashing shall be in a temporal pattern, synchronized with other units.
6. Strobe Leads: Factory connected to screw terminals.
7. Mounting Faceplate: Factory finished, red.

2.7 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.8 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 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.

2.9 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.

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.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

D. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. 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.

E. 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.
3. Smooth ceiling spacing shall not exceed 30 feet (9 m) .
4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. 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.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install 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.

3.3 PATHWAYS

A. Pathways shall be installed in EMT.

B. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. 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. Supervisory connections at valve supervisory switches.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications 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 owner’s representative.

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 visible appliances for the public operating mode according to manufacturer's written instructions.
5. 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. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 31 05 13

SOILS FOR EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Subsoil.
2. Topsoil.

B. Related Requirements:

1. Section 31 05 16 "Aggregates for Earthwork" for coarse and fine aggregate materials.
2. Section 31 23 16 "Excavation" for excavating as required for building foundations and utilities within building perimeter.
3. Section 31 23 16.13 "Trenching" for excavating as required for building foundations and utilities within building perimeter.
4. Section 31 23 23 "Fill" for backfilling as required at building perimeter and Site structures to subgrade elevations.
5. Section 31 25 00 "Erosion and Sedimentation Controls" for slope protection and erosion control.
6. Section 32 05 13 "Soils for Exterior Improvements" for subsoil and topsoil materials.
7. Section 32 05 16 "Aggregates for Exterior Improvements" for coarse and fine aggregate materials.
8. Section 32 92 23 "Sodding" for preparation of subsoil, placement of topsoil, fertilization, sod installation, and maintenance.
9. Document “MIKE MONRONEY AERONAUTICALCENTER IWTP UPGRADES, TERRACON PROJECT NO. 03255131” for geotechnical report; bore hole locations, findings of subsurface materials and recommended material types.

1.3 SUBMITTALS

A. Product Data:

1. Subsoil.
2. Topsoil.

B. Samples: Submit, in airtight containers, 10-lb sample of each type of fill to testing laboratory.

C. Source Quality-Control Reports: For subsoil and topsoil materials.

1.4 QUALITY ASSURANCE

A. Furnish each subsoil and topsoil material from single source throughout Work.

B. Perform Work according to Oklahoma City Department of Public Works standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 SUBSOIL

A. Type S1: Comply with Oklahoma Department of Transportation standard.

B. Type S2 Ordinary Borrow:

1. Ordinary borrow consists of well-graded mineral soil substantially free of organic materials, loam, wood, trash, and other objectionable material which may be compressible or which cannot be compacted properly.
2. Ordinary borrow consist of a material satisfactory to the Engineer and not specified as gravel borrow, sand borrow, special borrow material, or other particular kind of borrow.
3. This material conforms to the physical characteristics of soils designated as group A-1, A-2-4, or A-3 under AASHTO M 145.
4. Must be readily spread and compacted for the formation of foundations, embankments, and other subgrade improvements.
5. Liquid Limit: A-1 and A-3 = none or not measured, A-2-4 = 40 max.
6. Plasticity Index: A-1 = 6 max, A-3 = Non-Plastic (NP), A-2-4 = 10 max.

C. Type S2-b Pipe Bedding Material and Drainage Layer:

1. Bedding and drainage material under loam and around utilities is comprised of natural mineral sand within the following gradation limits:

a. Percent Passing According to Sieve Size:

1) 1/2 Inch: 100.

2) 3/8 Inch: 100 to 85.
3) No. 4: 100 to 60.
4) No. 16: 80 to 35.
5) No. 50: 55 to 10.
6) No. 200: 10 to 2.

D. Structural Fill:

1. See Geotechnical Report for Low Volume Change Material and ODOT Type "A".

E. Flowable Fill:

1. Flowable Fill to consist of Portland cement, fly ash, and/or slag cement and fine aggregate. Include the dry weights of cementitious material(s); quality and gradation of aggregates in the saturated surface-dry weights along with gradation tests; quantities, types, and names of admixtures; and quantity of water per cubic yard.

F. TOPSOIL

G. Topsoil Excavated On-Site Or Imported Borrow Friable Loam:

1. Select
2. Graded and double screened.
3. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds, and foreign matter.
4. Comply with ASTM D2487 Group Symbol OH.

2.3 SOURCE QUALITY CONTROL

A. Testing and Analysis:

B. Certificate of Compliance:

1. If supplier is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at source conforms to Contract Documents.
2. Specified source tests are not required for Work performed by approved supplier.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.

3.2 INSTALLATION OF SUBSOIL AND TOPSOIL

A. Excavation:

1. Excavate subsoil and topsoil from designated areas.
2. Strip topsoil to full depth of topsoil in designated areas.
3. Remove excess excavated materials, subsoil, and topsoil not intended for reuse from Site.
4. Remove excavated materials not meeting requirements for subsoil and topsoil materials from Site.
5. All utility trenches penetrating beneath building to be sealed with trench plug that extends a minimum of 5 feet from the face of the building exterior. Plug material to consist of cementitious flowable fill or low permeability clay. Trench plug material should be placed to surround the utility line. If used, clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill.

B. Stockpiling:

1. Stockpile excavated material meeting requirements for subsoil and topsoil materials.
2. Stockpile materials on Site at locations as designated by Authority.
3. Stockpile in sufficient quantities to meet Project schedule and requirements.
4. Separate differing materials with dividers or stockpile apart to prevent intermixing of soil types or contamination.
5. Stockpile topsoil maximum 8 feet high.
6. Direct surface water away from stockpile to prevent erosion or deterioration of materials.

7. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching until they are disposed.

3.3 CLEANING

A. Stockpile:

1. Remove stockpile and leave area in clean and neat condition.

    a. Grade Site surface to prevent freestanding surface water.

2. Leave unused materials in neat, compact stockpile.

END OF SECTION

SECTION 31 05 16

AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Coarse aggregate.
2. Fine aggregate.

B. Related Requirements:

1. Section 31 05 13 "Soils for Earthwork" for granular fill, topsoil, and grading materials.
2. Section 31 23 16 "Excavation" for excavating as required for building foundations and utilities within building perimeter.
3. Section 31 23 16.13 "Trenching" for excavating as required for building foundations and utilities within building perimeter.
4. Section 31 23 23 "Fill" for backfilling as required at building perimeter and Site structures to subgrade elevations.
5. Section 31 25 00 "Erosion and Sedimentation Controls" for slope protection and erosion control.
6. Section 31 05 16 "Aggregates for Exterior Improvements" for coarse and fine aggregate materials.
7. Section 33 14 16 "Site Water Utility Distribution Piping" for pipe materials, fittings, valves, meters, and backflow preventers.
8. Section 33 31 00 "Sanitary Sewerage Piping" for pipe materials and accessories normally encountered with gravity sanitary building piping.
9. Document "Mike Monroney Aeronautical Center IWTP Upgrades, Terracon Project No. 03255131” for geotechnical report; bore hole locations and findings of subsurface materials.

1.3 SUBMITTALS

A. Product Data:

1. Fine aggregate.
2. Coarse aggregate.
3. Submit name of imported materials source.

B. Samples: Submit, in airtight containers, 10-lb. sample of each type of aggregate to testing laboratory.

C. Source Quality-Control Reports: For fine- and coarse-aggregate materials.

1.4 QUALITY ASSURANCE

A. Furnish each coarse and fine-aggregate material from single source throughout Work.

B. Perform Work according to Oklahoma City Department Of Public Works standards.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation (ODOT) standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 COARSE AGGREGATE

A. Type A1: Comply with ODOT standards.

B. Type A2 Gravel Borrow:

1. Gravel borrow consists of processed inert fill material that is hard durable stone and coarse sand, free from loam and clay, surface coatings, and deleterious materials. Gradation requirements are determined by AASHTO T11 and T27 and conform to the following gradation:

a. Percent Passing According to Sieve Size:

1) 2 Inches: 100
2) 1/2 Inch: 50 to 85
3) No. 4: 40 to 75
4) No. 50: 8 to 28
5) No. 200: 0 to 8
6) Liquid Limit: Not greater than 25
7) Plasticity Index: Not greater than 6, according to ASTM D4318.

C. Type A3 Crushed Stone:

1. Crushed stone consists of one of the following materials:

a. Durable crushed rock consisting of angular fragments obtained by breaking and crushing solid or shattered natural rock, and free from a detrimental

quantity of thin, flat, elongated, or other objectionable pieces. A detrimental quantity will be considered as any amount in excess of 15 percent of the total weight.

1) Thin stones are considered to be such stones whose average width exceeds four times their average thickness. Elongated stones are considered to be such stones whose average length exceeds four times their average width.

b. Durable crushed gravel stone obtained by artificial crushing of gravel boulders or fieldstone with a minimum diameter before crushing of 8 inches.

2. Provide crushed stone reasonably free from clay, loam, or deleterious material with not more than 1.0 percent of satisfactory material passing a No. 200 sieve allowed to adhere to the crushed stone. Where crushed stone is to be used for surfacing, this requirement shall be not more than 0.5 percent of satisfactory material passing a No. 200 sieve.

a. Percent Passing According to Sieve Size:

1) 1-1/2 Inches: 100
2) 1-1/4 Inches: 85 to 100
3) 3/4 Inch: 10 to 40
4) 1/2 Inch: 0 to 8

D. Type A3a Dense Graded Crushed Stone for Sub-base:

1. Graded crushed stone for sub-base material combines crusher-run coarse aggregates of crushed stone and fine aggregates uniformly premixed with a predetermined quantity of water. Coarse aggregate consists of hard, durable particles of fragments of stone. Materials that break up when alternately frozen and thawed or wetted and dried are not acceptable. Provide coarse aggregate with a percentage of wear, by the Los Angeles Abrasion Test, of not more than 45. Fine aggregate consists of natural or crushed sand. Provide the composite material free from clay, loam, or other plastic material, which conforms to the following gradation requirements:

a. Percent Passing According to Sieve Size:

1) 2 Inches: 90 to 100
2) 1-1/2 Inches: 70 to 100
3) 3/4 Inch: 50 to 85
4) No. 4: 30 to 55
5) No. 50: 8 to 24
6) No. 200: 3 to 10

E. Type A4 Pea Gravel:

1. Stone: Natural.
2. Quality: Free of clay, shale, and organic matter.

3. Grading:

    a. Comply with ASTM C136/C136M, ASTM D2487; Group Symbol GM, ASTM D2487; Group Symbol GC, ASTM D2487; Group Symbol
    b. Minimum Size: 1/4 inch
    c. Maximum Size: 5/8 inch

2.3 FINE AGGREGATE

A. Type A5: Comply with ODOT standard.

B. Type A6 Natural River or Bank Sand, Washed:

1. Quality: Free of silt, clay, loam, friable or soluble materials, and organic matter.
2. Grading: Comply with ASTM C136, ASTM D2487; Group Symbol SW, ASTM D2487; Group Symbol SP, ASTM D2487; Group Symbol SM, ASTM D2487; Group Symbol SC, ASTM D2487; Group Symbol
3. Percent Passing According to Sieve Size:

    a. No. 4: 100
    b. No. 14: 10 to 100
    c. No. 50: 5 to 90
    d. No. 100: 4 to 30
    e. No. 200: Zero

C. Type A7 Blended Aggregate:

1. Produce blended aggregate by intermixing two or more fine or coarse aggregates to produce an aggregate combination with improved grading or other properties.
2. Percent Passing According to Sieve Size:

    a. 3/8 Inch: 100
    b. 1/4 Inch: 98 to 100
    c. No. 4: 90 to 100
    d. No. 10: 56 to 76
    e. No. 20: 40 to 54
    f. No. 40: 25 to 45
    g. No. 80: 13 to 29
    h. No. 200: 4 to 10

2.4 SOURCE QUALITY CONTROL

A. Testing and Analysis:

1. Coarse-Aggregate Material: Comply with ASTM C136.
2. Fine-Aggregate Material: Perform according to ASTM C136.
3. If tests indicate materials do not meet specified requirements, change material and retest.

B. Owner or Authority Inspection:

1. Make coarse aggregate and fine aggregate available for inspection at source prior to loading for shipment.
2. Notify Owner or Authority at least seven days before inspection is allowed.

C. Owner or Authority Witnessing:

1. Allow witnessing of source testing at supplier's facility.
2. Notify Owner or Authority at least seven days before tests are scheduled.

D. Certificate of Compliance:

1. If supplier is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at source conforms to Contract Documents.
2. Specified source tests are not required for Work performed by approved supplier.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION OF COARSE AGGREGATE AND FINE AGGREGATE

A. Excavation:

1. Excavate aggregate materials from Site locations as indicated designated by Architect/Engineer and as specified in Section 31 23 16 "Excavation.” 31 23 16.13 "Trenching."
2. Remove excess excavated coarse-aggregate and fine-aggregate materials not intended for reuse from Site.
3. Remove excavated materials not meeting requirements for coarse aggregate and fine aggregate from Site.

B. Stockpiling:

1. Stockpile materials on Site at locations as designated by Authority.
2. Stockpile excavated material meeting requirements for coarse-aggregate and fine-aggregate materials.
3. Stockpile in sufficient quantities to meet Project schedule and requirements.
4. Separate different aggregate materials with dividers or stockpile apart to prevent intermixing of aggregate types or contamination.
5. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

6. Stockpile unsuitable and hazardous materials on impervious material and cover to prevent erosion and leaching until they are disposed.

3.3 CLEANING

A. Stockpile:

1. Remove stockpile and leave area in clean and neat condition.

   a. Grade Site surface to prevent freestanding surface water.

2. Leave unused materials in neat, compact stockpile.

END OF SECTION

SECTION 31 23 16

EXCAVATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Soil densification.
2. Excavating for building foundations.
3. Excavating for paving and parking areas.
4. Excavating for slabs on grade.
5. Excavating for Site structures.
6. Excavating for landscaping.

B. Related Requirements:

1. Section 31 05 13 "Soils for Earthwork" for stockpiling of fill and grading materials.
2. Section 31 05 16 "Aggregates for Earthwork" for stockpiling of coarse- and fine-aggregate materials.
3. Section 31 22 13 "Rough Grading" for topsoil and subsoil removal from Site surface.
4. Section 31 23 16.13 "Trenching" for excavating as required for building foundations and utilities within building perimeter.
5. Section 31 23 23 "Fill" for backfilling at building perimeter and Site structures, and fill under slabs on grade, pavement, and landscaped areas.
6. Section 31 25 00 "Erosion and Sedimentation Controls" for slope protection and erosion control.
7. Section 33 14 16 "Site Water Utility Distribution Piping" for pipe materials, fittings, valves, meters, and backflow preventers.
8. Section 33 31 00 "Sanitary Sewerage Piping" for pipe materials and accessories normally encountered with gravity sanitary building piping.

9. Document "Mike Monroney Aeronautical Center IWTP Upgrades, Terracon Project No. 03255131” for geotechnical report, bore hole locations, and findings of subsurface materials.

1.3 SUBMITTALS

A. Shop Drawings:

1. Indicate soil densification grid for each size and configuration footing requiring soil densification.
2. Excavation Protection Plan:

    a. Describe sheeting, shoring, and bracing materials and installation, as required, to protect excavations and adjacent structures and property.
    b. Submit signed and sealed Shop Drawings with design calculations and assumptions to support plan.

B. Field Quality-Control Reports: For Contractor-furnished tests and inspections.

C. Qualifications Statement: For licensed professional.

1.4 QUALITY ASSURANCE

A. Licensed Professionals Qualifications: Professional engineer experienced in design of specified Work and licensed in State of Oklahoma.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Applicator present for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.

3.2 PREPARATION

A. Call local utility line information service not less than three working days before performing Work.

B. Request that underground utilities be located and marked within and immediately surrounding construction areas.

C. Identify required lines, levels, contours, and data.

D. Existing Utilities:

1. Notify utility company to remove and relocate utilities.
2. Protect from damage utilities indicated to remain.

E. Protect plant life, lawns, and other features designated to remain as portion of final landscaping.

F. Protect benchmarks, existing structures, fences, sidewalks, paving, curbs, and survey control points from excavating equipment and vehicular traffic.

G. Do not close or obstruct roadways, sidewalks, and hydrants without permits.

H. Erect and maintain temporary barriers and security devices, including warning signs, warning lights, and similar measures, for protection of public, and existing improvements indicated to remain.

3.3 EXCAVATION

A. Underpin adjacent structures which may be damaged by excavation Work.

B. Excavate subsoil to accommodate building foundations, slabs on grade, paving, and construction operations.

C. Excavate to working elevation for piling Work.

D. Compact disturbed load-bearing soil in direct contact with foundations to original bearing capacity as specified in Section 31 23 23 "Fill" and Section 31 23 16.13 "Trenching".

E. Slope banks with machine to angle of repose or less until shored. All excavations over 4 feet must be stepped or shored per OSHA requirements.

F. Do not interfere with 45-degree bearing splay of foundations.

G. Grade top perimeter of excavation to prevent surface water from draining into excavation.

H. Trim excavation and remove loose matter.

I. Removal of Deleterious Materials:

1. Remove lumped subsoil, boulders, and rock up to 1/3 cu. yd., measured by volume.
2. Remove larger material as specified in Section 31 23 23 "Fill".
3. Remove excess and unsuitable material from Site.

J. Notify Architect/Engineer of unexpected subsurface conditions.

K. Correct over-excavated areas with structural fill as directed by Architect/Engineer.

1. Remove excavated material from Site.
2. Stockpile subsoil in area designated on Site to depth not exceeding 8 feet and protect from erosion.
3. Stockpile excavated material in area designated on Site as specified in Section 31 05 13 "Soils for Earthwork"

L. Repair or replace items indicated to remain that have been damaged by excavation.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Request visual inspection of bearing surfaces by inspection agency before installing subsequent Work.

B. Prepare test and inspection reports.

3.5 PROTECTION

A. Prevent displacement or loose soil from falling into excavation and maintain soil stability.

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

C. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that may be created by earth operations.

END OF SECTION

SECTION 31 23 16.13

TRENCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Excavating trenches for utilities from 5 feet outside building to utility service.
2. Compacted fill from top of utility bedding to subgrade elevations.
3. Fill materials.
4. Trench shoring shields or boxes.
5. Temporary steel plates.
6. Geotextiles.
7. Backfilling and compaction.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for concrete materials.
2. Section 31 05 13 "Soils for Earthwork" for soils for fill.
3. Section 31 05 16 "Aggregates for Earthwork" for aggregates for fill.
4. Section 31 22 13 "Rough Grading" for topsoil and subsoil removal from Site surface.
5. Section 31 23 16 "Excavation" for general building excavation.
6. Section 31 23 23 "Fill" for general backfilling.
7. Section 33 31 00 "Sanitary Sewerage Piping" for sanitary sewer piping and bedding from building to utility service.
8. Document "Mike Monroney Aeronautical Center IWTP Upgrades, Terracon Project No. 03255131” for geotechnical report, bore hole locations, and findings of subsurface materials.

1.3 DEFINITIONS

A. Excavator: Any entity including, but not limited to, a person, partnership, joint venture, trust, corporation, association, public utility, company, or state or local government body or public agency which performs excavation operations, including the excavation of trenches.

B. Trench: An excavation which is narrow in relation to its length and deeper than it is wide, made more than three feet below grade, with width no greater than 15 feet as measured from the bottom.

C. Trench Shoring: The methods and equipment, including shores and props, used to brace the walls of a trench during excavation work and to prevent the trench walls from collapsing into the trench. Also referred to as trench bracing or trench lining.

D. Utility: Any buried pipe, duct, conduit, or cable.

1.4 SUBMITTALS

A. Excavation Protection Plan: Describe sheeting, trench shoring shields, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan. Prepare design calculations and drawings, stamped and signed by a professional engineer registered in the State of Oklahoma, who is experienced in designing excavation support systems.

B. Product Data: Submit data for sheeting, shoring, trench shoring shields, and geotextile fabric indicating fabric and construction.

C. Samples:

1. Submit, in airtight containers, 10-lb. sample of each type of fill to testing laboratory.
2. Submit two samples, full width by 36 inches long, for each type and weight of geotextile used on Project, illustrating thickness and seaming method.

D. Source Quality-Control Reports: For subsoil.

E. Material Test Reports: For each fill material, by a qualified testing agency.

F. Field Quality-Control Reports: For fill material placement and compaction.

1.5 SUSTAINABLE DESIGN SUBMITTALS

A. Product Certificates:

1. For the source and origin for fine and coarse aggregate materials.
2. For the source for regional fine and coarse aggregate materials and distance from Project Site.
3. For the source and origin for trench shoring shields and woven and nonwoven geotextile materials.
4. For the source for regional trench shoring shields and woven and nonwoven geotextile materials and distance from Project Site.
5. For recycled trench shoring shields, and geotextile material content for recycled content products.

1.6 QUALITY ASSURANCE

A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

C. Licensed Professionals Qualifications: Professional engineer experienced in design of specified Work and licensed State of Oklahoma.

D. Furnish each coarse and fine aggregate material from single source throughout Work.

1.7 PROTECTION OF UNDERGROUND FACILITIES

A. The Contractor will conduct an investigation to assure that no damage to existing structures, drainage lines, utilities, or conduits will occur.

B. The Contractor is required to use caution when encountering active or abandoned utility structures to avoid possibly disturbing or damaging asbestos-containing materials (ACM), which may be present. The Contractor will notify the Architect/Engineer of any suspected ACM encountered in Site utility structures and is responsible for arranging testing of the suspect material by polarized light microscopy (PLM) or other approved method before proceeding with any Work that would disturb the structures.

C. While the excavation is open, protect, support, or remove underground installations as necessary.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 FILL MATERIALS

A. Subsoil Fill: Type S1 as specified in Section 31 05 13 "Soils for Earthwork**"**.

B. Structural Fill: Type S1, S2, S2-d as specified in Section “31 05 16 "Aggregates for Earthwork".

C. Granular Fill: Type A1, A2, A3, A3a, A7 as specified in Section 31 05 16 "Aggregates for Earthwork".

D. Concrete: Structural concrete as specified in Section 03 30 00 "Cast-in-Place Concrete" with compressive strength of 2,500 psi.

2.3 TRENCH SHORING SHIELDS OR BOXES

A. Provide professional engineer-certified, medium-duty, single-wall or double-wall high-strength steel trench shields or boxes with the following characteristics:

1. Modular shoring system.
2. 4-inch, 6-inch, or 8-inch wall thickness standard.
3. Foam-filled option.
4. Interchangeable Widths: Schedule 80 pinned-in-place steel pipe spreaders.
5. Lifting lugs standard.
6. Hardwood filled top boards.
7. Stackable.
8. Reinforced cutting edges.
9. Choice of Heights: 4-foot, 6-foot, 8-foot, or 10-foot high panels.
10. Minimum five standard lengths.
11. Dual purpose end posts accept either panels, screw jacks, or spreaders allowing two-, three-, or four-sided shields using the same components.

B. Manufacturers:

1. American Shoring Inc.
2. ESC Trench Shoring.
3. PRO-TEC Equipment.
4. Trench Shoring Company.

2.4 TEMPORARY STEEL PLATES

A. Place temporary steel plates over all saw cuts and trenches in roadway areas that will be subjected to traffic during installations to allow for the passage of vehicular traffic.

B. Design the steel plates to size and thickness capable of supporting HS-20 loading, but not less than one inch thick.

C. Submit design criteria and calculations that determine the sizes to be used to Architect/Engineer for approval.

D. Completely cover the opening with plates and overlap a minimum of 24 inches on all sides.

1. Secure the plates to pavement with spikes or similar devices to prevent any movement of the plates.
2. Place bituminous concrete around the edges of the steel plating to provide a smooth transition on and off the plates for vehicles.
3. When the steel plating is removed, also remove the temporary bituminous concrete.

2.5 GEOTEXTILES

A. Filtration Fabric: Provide to line pipe trenches according to Section 31 05 19.13 "Geotextiles for Earthwork," Paragraph 2.3 - Nonwoven Geotextile Materials.

B. Erosion Control: Provide erosion control and subsurface drainage geotextile as required for trench Work according to Section 31 05 19.13 "Geotextiles for Earthwork," Paragraph 2.4 - Woven Geotextiles for Erosion Control.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Installer present for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.

B. Proceed with trench excavation only after unsatisfactory conditions have been corrected.

3.2 LINES AND GRADES

A. Lay pipes and conduit to lines and grades as indicated on Drawings.

1. Owner reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

C. Maintain grade alignment of pipe and conduit using string line parallel with grade line and vertically above centerline of pipe or conduit.

1. Establish string line on level batter boards at intervals of not more than 25 feet.
2. Install batter boards spanning trench, rigidly anchored to posts driven into ground on both sides of trench.
3. Set three adjacent batter boards before laying pipe to verify grades and line.
4. Determine elevation and position of string line from elevation and position of offset points or stakes located along pipe or conduit route.
5. Do not locate pipe or conduit using side lines for line or grade.

3.3 PREPARATION

A. Call local utility line information service at or less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.
2. If utilities are to remain in place, provide adequate means of protecting during trench excavation operations.

3. Should uncharted or incorrectly charted piping or other utilities be encountered during trench excavation, consult Architect/Engineer immediately for directions. Cooperate with Architect/Engineer and public utility service companies as required to keep their respective services and facilities in operation. Repair damaged utilities to the satisfaction of Architect/Engineer, Owner and utility company.

B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, and other features remaining as portion of final landscaping.

D. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

E. Maintain and protect above- and below-grade utilities indicated to remain.

F. Establish temporary traffic control and detours when trenching is performed within roadway, or in public right-of-way. Relocate controls and reroute traffic as required and approved by Owner during progress of Work.

3.4 TRENCHING

A. Excavate subsoil required for utilities to utility service.

B. Remove lumped subsoil, boulders, and rock more than 1/6 cu. yd., measured by volume.

C. Perform excavation within 24 inches of existing utility service according to utility's requirements.

D. Do not advance open trench more than 200 feet ahead of installed pipe or conduit.

E. Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work according to OSHA 29 CFR 1926.650.

F. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe or conduit.

G. Excavate trenches to depth as indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe, conduit, and utilities.

H. Do not interfere with 45-degree bearing splay of trench or foundations.

I. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe or conduit. When side walls cannot be sloped, provide sheeting and trench shoring shields to protect excavation as specified in this Section.

J. When subsurface materials at bottom of trench are loose or soft, notify Architect/Engineer and request instructions.

K. Cut out soft areas of subgrade not capable of compaction in place. Backfill and compact to density equal to or greater than requirements for subsequent backfill material.

L. Trim excavation. Remove loose matter.

M. Correct over-excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Architect/Engineer.

N. Remove from Site excess subsoil not intended for reuse.

O. Remove subsoil from Site.

P. Stockpile subsoil in area designated on Site to depth not exceeding 8 feet and protect from erosion.

Q. Stockpile excavated material in area designated on Site by Owner.

R. Locate a stairway, ladder, ramp, or other safe means of egress in trench excavations that are 4 feet or more in depth to require no more than 25 feet of lateral travel for personnel.

3.5 SHEETING, SHORING, AND TRENCH SHORING SHIELDS

A. Utilize sheeting, shoring, and trench shoring shields and brace excavations to prevent danger to persons, structures, and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, trench shoring shields, or other protection to maintain stability of excavation.

C. When sheeting is used, drive it ahead of the excavation operations to avoid the loss of material from behind the sheeting. Fill voids that occur outside of the sheeting with gravel borrow, thoroughly compacted.

D. Assemble and place trench shoring shields according to manufacturer's written instructions.

E. Design sheeting and shoring to be removed at completion of excavation Work.

F. Repair damage caused by failure of the sheeting, shoring, trench shoring shields, or bracing and for settlement of filled excavations or adjacent soil.

G. Repair damage to new and existing Work from settlement, water pressure, earth pressure, or other causes resulting from inadequate sheeting, shoring, trench shoring shields, or bracing.

3.6 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. All utility trenches penetrating beneath building to be sealed with trench plug that extends a minimum of 5 feet from the face of the building exterior. Plug material to consist of cementitious flowable fill or low permeability clay. Trench plug material should be placed to surround the utility line. If used, clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill. Refer to "31 05 13 Soils for Earthwork" for flowable fill requirements.

C. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

D. Place geotextile fabric over subgrade prior to placing subsequent fill materials.

E. Place fill material in continuous layers and compact.

F. Place material in continuous layers as follows:

1. Subsoil Fill: Maximum 8 inches compacted depth.
2. Structural Fill: Maximum 6 inches compacted depth.
3. Granular Fill: Maximum 6 inches compacted depth.

G. Employ placement method that does not disturb or damage foundation perimeter drainage, or utilities in trench.

H. Maintain optimum moisture content of fill materials to attain required compaction density.

I. Do not leave more than 50 feet of trench open at end of working day.

J. Protect open trench to prevent danger to Owner and the public.

3.7 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.

3.8 FIELD QUALITY CONTROL

A. Perform laboratory material tests according to ASTM D1557.

B. Perform in place compaction tests according to the following:

1. Density Tests: ASTM D1556 or ASTM D6938.
2. Moisture Tests: ASTM D6938.

C. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

D. Frequency of Tests: 100 linear feet.

3.9 PROTECTION OF FINISHED WORK

A. Reshape and recompact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 31 23 23

FILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fill materials.
2. Geotextiles.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for concrete materials.
2. Section 31 05 13 "Soils for Earthwork" for soils for fill.
3. Section 31 05 16 "Aggregates for Earthwork" for aggregates for fill.
4. Section 31 23 16 "Excavation" for backfilling of building foundations and utilities within building perimeter.
5. Section 31 23 16.13 "Trenching" for backfilling of utility trenches.
6. Section 33 14 16 "Site Water Utility Distribution Piping" for pipe materials, fittings, valves, meters, and backflow preventers.
7. Section 33 31 00 "Sanitary Sewerage Piping" for pipe materials and accessories normally encountered with gravity sanitary building piping.
8. Section 33 41 13 "Foundation Drainage" for filter aggregate.
9. Section 33 41 19 "Underslab Drainage" for filter aggregate.
10. Section 33 42 00 "Stormwater Conveyance" for drainage facilities to collect and provide for flow of stormwater.
11. Document "Mike Monroney Aeronautical Center IWTP Upgrades, Terracon Project No. 03255131” for geotechnical report, bore-hole locations, and findings of subsurface materials.

1.3 SUBMITTALS

A. Product Data: For fill materials and geotextiles.

B. Samples:

1. Submit, in airtight containers, one 10-lb. sample of each type of fill to testing laboratory.

2. Submit two samples, full width by 36 inches long, for each type and weight of geotextile used on Project, illustrating thickness and seaming method.

C. Source Quality-Control Reports: For subsoil.

D. Material Test Reports: For each fill material, by a qualified testing agency.

E. Field Quality-Control Reports: For fill material placement and compaction.

1.4 SUSTAINABLE DESIGN SUBMITTALS

A. Product Certificates:

1. For the source and origin for fine- and coarse-aggregate materials.
2. For the source for regional fine- and coarse-aggregate materials, lean and structural concrete, and distance from Project Site.
3. For the source and origin for woven and nonwoven geotextile materials and distance from Project Site.

1.5 QUALITY ASSURANCE

A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

C. Licensed Professionals Qualifications: Professional engineer experienced in design of specified Work and licensed in State of Oklahoma.

D. Furnish each coarse and fine aggregate material from single source throughout Work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 FILL MATERIALS

A. Subsoil Fill: Type S1 S2, as specified in Section 31 05 13 "Soils for Earthwork".

B. Structural Fill: Type S1 S2 S2-d A1 A2 A3 A3a A7, as specified in Section 31 05 13 "Soils for Earthwork".

C. Granular Fill: Type A1 A2 A3 A3a A7, as specified in Section 31 05 16 "Aggregates for Earthwork".

D. Concrete:

1. Lean concrete.
2. Structural concrete, as specified in Section 03 30 00 "Cast-in-Place Concrete".

a. Compressive Strength: 2,500 psi.

2.3 GEOTEXTILES

A. Geotextile Fabric: Provide erosion control, subsurface drainage, and soil reinforcement geotextile as required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.

B. Verify that subdrainage, damp proofing, and waterproofing installations have been inspected.

C. Verify that underground tanks are anchored to their own foundations to avoid flotation after backfilling.

D. Verify structural integrity of unsupported walls to support loads imposed by fill.

3.2 PREPARATION

A. Call local utility line information service at 1-800-522-OKIE not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum.

C. Protect utilities indicated to remain free from damage.

D. Compact subgrade to specified density requirements for subsequent backfill materials.

E. Soft Subgrade:

1. Cut out soft areas of subgrade not capable of compaction in place.
2. Backfill with structural fill and compact to density equal to or greater than specified requirements for subsequent fill material.

F. Scarify subgrade surface to depth of 8 inches.

G. Protect benchmarks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.3 BACKFILLING

A. Backfill areas to contours and elevations.

B. Systematically backfill to allow maximum time for natural settlement.

C. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces, and do not backfill with frozen materials.

D. Geotextile: Place geotextile fabric over Subgrade prior to placing subsequent fill materials.

E. Place fill material in continuous layers and compact.

F. Maximum Compacted Depths:

1. Place material in continuous layers to following depths:

a. Subsoil Fill: Maximum 8 inches compacted depth.
b. Structural Fill: Maximum 6 inches compacted depth.
c. Granular Fill: Maximum 6 inches compacted depth.

G. Use placement method that does not disturb or damage foundation perimeter drainage or utilities in trench.

H. Maintain optimum moisture content of fill materials to attain required compaction density.

I. Structures:

1. Backfill against supported foundation walls.
2. Backfill simultaneously on each side of unsupported foundation walls and utility structures until supports are in place.
3. Slope grade away from building minimum 2 percent slope for minimum distance of 10 feet.

J. Make gradual grade changes and blend slope into level areas.

K. Remove surplus backfill materials from Site.

L. Leave fill material stockpile areas free of excess fill materials.

M. Install Work according to Oklahoma City Engineering Department standards.

3.4 TOLERANCES

A. Top Surface of Backfilling within Building Areas: Plus or minus 1 inch from required elevations.

B. Top Surface of Backfilling under Paved Areas: Plus or minus 1 inch from required elevations.

C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.5 FIELD QUALITY CONTROL

A. Inspections: Request visual inspection of bearing surfaces by inspection agency before installing subsequent Work.

B. Testing:

1. Laboratory Material Testing: Comply with ASTM D6938.
2. In-Place Compaction Testing:

    a. Density Tests: Comply with ASTM D6938.
    b. Moisture Tests: Comply with ASTM D6031/D6031M.

3. If tests indicate that Work does not meet specified requirements, remove Work, replace, compact, and retest.
4. Testing Frequency: Under Sidewalks - One Test Every 2000 Ft^2 Of Each Base Or Sub-Base Lift. Backfill Of Trenches - One Test For Every 100 Linear Ft Of Each Lift.
5. Proof-roll compacted fill surfaces under slabs on grade, and paving.

3.6 PROTECTION

A. Reshape and recompact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROLS

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rock materials.
2. Concrete materials and reinforcement.
3. Block, stone, aggregate, and soil materials.
4. Planting materials.
5. Pipe materials.
6. Stabilized construction entrances.
7. Siltation control devices.
8. Erosion control devices.
9. Anchoring devices.
10. Accessories.

B. Related Requirements:

1. Division 31 and related specifications.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Rock materials.
2. Concrete materials and reinforcement.
3. Block, stone, aggregate, and soil materials.
4. Planting materials.
5. Pipe materials.
6. Stabilized construction entrances.
7. Siltation control devices.
8. Erosion control devices.
9. Anchoring devices.
10. Accessories.

B. Stormwater Pollution Prevention Plan (SWPPP): As specified in "Quality Assurance" Article.

C. Submit name and applicable experience of soil erosion and sediment control manager according to Section 1.5 F.

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports: Indicate certified tests results for precast concrete at manufacturing facility, cast-in-place concrete in field, and granular backfill.

1.5 QUALITY ASSURANCE

A. Perform Work according to Oklahoma Department of Environmental Quality.

B. Progress Schedule:

1. Clearly outline intended maintenance of traffic, locations where temporary and permanent soil erosion and sediment control measures will be installed, and such other information as required.
2. Provide special consideration to sensitive areas such as wetlands and waterways.
3. Incorporate appropriate staging and seasonal constraints to maximize the effectiveness of the soil erosion and sediment controls.
4. Indicate when Work is restricted in these sensitive areas as outlined in permits issued by regulatory agencies.

C. Soil Erosion and Sediment Control Manager:

1. Assign to the Project a supervisory-level employee to serve in the capacity of soil erosion and sediment control manager. This employee is required to be thoroughly experienced in all aspects of soil erosion and sediment control and construction. Submit the name and experience of this employee to the Engineer or approval at least 10 working days prior to commencing any Work on the Project.
2. Assigned manager will be responsible for the following:

    a. Implement approved soil erosion and sediment control schedules and methods of operations.
    b. Coordinate operations with the Owner and oversee and supervise all aspects of soil erosion and sediment control Work for the Project.
    c. Attend all soil erosion and sediment control meetings during the Contract.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 STABILIZED CONSTRUCTION ENTRANCES

A. Stone Size: Use ASTM C33/C33M, size No. 2 1.5 to 2.5 inches. Use crushed stone.

B. Length: As effective, but not less than 50 feet.

C. Thickness: Not less than 8 inches.

D. Width: Not less than full width of all points on ingress or egress, minimum 25 feet.

E. Washing: When necessary, clean wheels to remove sediment prior to entrance onto public right-of-way. When washing is required, provide an area stabilized with crushed stone that drains into an approved sediment trap or sediment basin. Prevent all sediment from entering any storm drain, ditch, or watercourse by using sandbags, gravel boards, or other approved methods.

F. Maintenance: Maintain entrance in a condition that will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional stone as conditions demand and repair or cleanout of any measures used to trap sediment. All sediment spoiled, dropped, washed, or tracked onto public rights-of-way must be removed immediately.

2.3 SILTATION CONTROL DEVICES

A. Filter Socks:

1. Manufacturers:

    a. Filtrexx International/MKB Company
    b. L & M Supply; Core & Main LP
    c. Palcon, LLC
    d. The Cary Company

2. Provide filter socks consisting of a three-dimensional matrix of certified, composted organic material or other organic matter to create a filter medium. Fill the tubular mesh sock with organic filter material of wood chips or mulch that has been screened to remove fines, crushed stone, or gravel. Use crushed stone or gravel when the sock will be used on paved areas where the sock cannot be staked in place. Fill the sock with organic material by blowing the material into the tube with a special pneumatic blower truck or similar device. Hand filling with organic material is not an acceptable means to fill the tube as the material cannot be compacted in the sock.
3. Performance and Design Criteria:

    a. Mesh Material Type: Multi-filament polypropylene (MFPP) photodegradable.
    b. Uses: Standard sediment control applications.
    c. Mesh Opening Size: 1/8 inch.
    d. Available Diameters: 5 inches, 8 inches, 12 inches.
    e. Functional Longevity/Project Duration: Up to five years.
    f. Tensile Strength: MD - 670 lb.
    g. Locally sourced filter media.
    h. Mesh Color: Green, black, or tan.

B. On-Land Silt Fence:

1. Manufacturers:

a. Ten Cate Nicolon
b. US Silt & Site Supply

2. Provide on-land silt fence consisting of a woven fabric comprised of high-tenacity polypropylene yarns and a plastic net backing, square hardwood posts, and connection hardware or aluminum wire.
3. Performance and Design Criteria:

a. Grab Tensile Strength (Machine Direction): ASTM D4632/D4632M - 124 lb
b. Grab Tensile Strength (Cross-Machine Direction): ASTM D4632/D4632M - 124 lb.
c. Grab Tensile Elongation: ASTM D4632/D4632M - 15 percent.
d. Mullen Burst Strength: ASTM D3786/D3786M - 300 psi.
e. Trapezoid Tear Strength: ASTM D4533/D4533M - 65 lb.
f. Permittivity: ASTM D4491/D4491M - 0.10 sec^{-1}.
g. Water Flow Rate: ASTM D4491/D4491M - 10 gpm/sq. ft.
h. Ultraviolet Stability: ASTM D4355/D4355M - 70 percent.
i. Length: 100 feet.
j. Width: 3 feet.
k. Post Length: 4 feet.
l. Post Spacing: 8.3 feet.

4. Provide prefabricated commercial silt fence; may be substituted for built-in-field fence.

2.4 EROSION CONTROL DEVICES

A. Erosion Control Blankets:

1. Manufacturers:

a. American Excelsior Company
b. DeWitt
c. MKB Company, LLC
d. North American Green
e. Western Excelsior Company

2. 100 percent agricultural straw fiber matrix, 0.5 lb./sq. yd., stitch bonded with degradable thread between two photodegradable polypropylene nettings.
3. Securement: Staples used to anchor erosion control blankets should be U-shaped, 11-gage or heavier steel wire, having a span width of 1 inch and a length of 6 inches or more from top to bottom after bending.

B. Filtration Geotextile:

1. Manufacturers:

a. Carthage Mills
b. Hanes Geo Components; Leggett & Platt Incorporated
c. TenCate Geosynthetics
d. US Fabrics Inc
e. Willacoochee Industrial Fabrics

2. Provide woven filtration geotextile comprised of high-tenacity, monofilament, 100 percent polypropylene yarns, which resists ultraviolet and biological deterioration, rotting, and naturally encountered basics and acids. Place filtration geotextile on subgrade below riprap stone or as indicated.
3. Performance and Design Criteria:

a. Grab Tensile Strength: ASTM D4632 425 by 350 lb.
b. Grab Tensile Elongation: ASTM D4632 - 21 percent.
c. Wide Width Tensile Strength: ASTM D4595 - 3,240 by 2,700 lb./ft.
d. CBR Puncture: ASTM D6241 - 1,340 lb.
e. Trapezoid Tear Strength: ASTM D4533 - 145 by 125 lb.
f. Apparent Opening Size: ASTM D4751 - 40 U.S. sieve.
g. Permittivity: ASTM D4491 - 0.96 sec^{-1}.
h. Permeability: ASTM D4491 - 0.046 cm/s.
i. Water Flow Rate: ASTM D4491 - 70 gpm/sq. ft.
j. Percent Open Area: CW-02215 - 6 percent.
k. Ultraviolet Stability: ASTM D4355 - 90 percent.
l. Length: 300 feet.
m. Width: 12.5 feet.

2.5 ANCHORING DEVICES

A. Staples: Must be No. 8 gage steel wire, bent U-shapes with throat width equal to 1 to 2 inches, and effective driving depth of 6 inches or as suggested by the manufacturer.

B. Sandbags: Must be of proper size to temporarily stabilize fabric; number and weight sufficient to withstand wind speeds of 50 mph.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance.

B. Verify compacted stabilized soil is acceptable and ready to support devices and imposed loads.

C. Verify gradients and elevations of base or foundation for other Work are correct.

3.2 INSTALLATION OF ROCK MATERIALS

3.3 INSTALLATION OF FILTER SOCKS

A. Position filter socks as indicated and as necessary to prevent off-site movement of sediment produced by construction activities as directed by the Architect/Engineer and Construction Manager.

1. Install erosion control measures around all existing catch basins within the Project limits and in the adjacent affected areas, or as determined by the Architect/Engineer in the field.

B. Install stakes through the middle of the sediment control on minimum 10-foot centers. Depth of staking must be 12 inches for sand or silt and 8 inches for clay soils.

C. Install filter socks, as indicated, and stake as required.

D. Furnish, place, and maintain filter socks as specified and as shown. Remove upon completion of all Work.

3.4 INSTALLATION OF ON-LAND SILT FENCE

A. Position sediment fences as indicated on the Drawings and to prevent off-site movement of sediment produced by construction activities as directed by Architect/Engineer and Construction Manager. Provide areas beyond limits of silt fence undisturbed or stabilized.

B. Dig trench approximately 6 inches wide and 6 inches deep along proposed fence lines.

C. Drive stakes maximum 10 feet on center at back edge of trenches. Drive stakes minimum 2 feet into ground.

D. Hang filter fabric on posts carrying to bottom of trench with about 4 inches of fabric laid across bottom of trench. Stretch fabric taut along fence length and maintain secure both ways.

E. Backfill trench with excavated material and tamp.

F. Install prefabricated silt fence according to manufacturer's instructions.

3.5 STABILIZATION OF SITE

A. Incorporate erosion control devices indicated into the Project at the earliest practicable time.

B. Construct, stabilize, and activate erosion controls before Site disturbance within tributary areas of those controls.

C. Stockpile and waste pile heights must not exceed 35 feet. Slope stockpile sides at 2:1 or flatter.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.

1. During non-germinating periods, apply mulch at recommended rates.
2. Stabilize disturbed areas that are not at finished grade and which will be disturbed within one year according to Section 32 91 13 "Soil Preparation" and Section 32 92 19 "Seeding".
3. Stabilize disturbed areas that either are at finished grade or will not be disturbed within one year according to Section 32 91 13 "Soil Preparation" and Section 32 92 19 "Seeding" permanent seeding specifications.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.

C. Field test concrete according to Section 03 30 00 "Cast-in-Place Concrete".

D. Compaction Testing, Option 1: As specified in Section 31 23 23 "Fill".

E. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

F. Frequency of Compaction Testing: Two for each lift.

G. Prepare test and inspection reports.

3.7 CLEANING

A. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

B. Do not damage structure or device during cleaning operations.

C. Do not permit sediment to erode into construction or Site areas or natural waterways.

D. Clean channels when depth of sediment reaches approximately one-half channel depth.

3.8 PROTECTION

A. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit construction traffic over paving for seven days minimum after finishing until 75 percent design strength of concrete has been achieved.

C. Protect paving from elements, flowing water, or other disturbance until curing is complete.

END OF SECTION

SECTION 32 16 23

SIDEWALKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Aggregate subgrade.

B. Related Requirements:

1. Section 03 10 00 "Concrete Forming and Accessories" for form materials, waterstops, and accessories.
2. Section 03 20 00 "Concrete Reinforcing" for reinforcing steel and supports for cast-in-place concrete.
3. Section 03 30 00 "Cast-in-Place Concrete" for cast-in-place or in-situ concrete for structural building frames, slabs on fill or grade, and other concrete components.
4. Section 31 23 23 "Fill" for compacted subgrade for paving.

1.3 SUBMITTALS

A. Product Data:

1. Aggregate subgrade.
2. Submit required information regarding concrete materials**,** joint filler, admixtures, and curing compounds.
3. Mix Design:

    a. Submit concrete mix design for each concrete strength prior to commencement of Work.
    b. Submit separate mix designs if admixtures are required for hot- and cold-weather concrete Work.
    c. Identify mix ingredients and proportions, including admixtures.

4. Identify chloride content of admixtures and whether or not chloride was added during manufacture.

B. Source Quality-Control Reports: For aggregate subgrade.

C. Field Quality-Control Reports: For aggregate subgrade.

D. Qualifications Statements: For manufacturer and installer.

1.4 QUALITY ASSURANCE

A. Perform Work according to Sections 03 10 00 "Concrete Forming and Accessories", 03 20 00 "Concrete Reinforcing", and 03 30 00 "Cast-in-Place Concrete".

B. Obtain cementitious materials from same source throughout.

C. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years' experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.6 FIELD CONDITIONS

A. Minimum Conditions: Do not place concrete if base surface temperature is less than 40 degrees F, or if surface is wet or frozen.

B. Subsequent Conditions: Maintain minimum 50 degrees F, for not less than 72 hours after placing, and at a temperature above freezing for remainder of curing period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.3 AGGREGATE SUBGRADE

As specified in Section 310516 "Aggregates For Earthwork" Insert list of materials specified in this Section required to be regional materials.

2.4 MATERIALS

A. Forms:

1. Description: As specified in Section 03 10 00 "Concrete Forming and Accessories".
2. Height: Equal to full depth of finished sidewalk.
3. Material:

    a. Wood: Straight and free from warping, twisting, loose knots, splits, or other defects.
    b. Steel: Channel-formed sections.

4. Profile: To suit conditions.
5. Joint Filler:

    a. Asphalt-impregnated fiberboard or felt.
    b. Thickness: 1/2 inch.

    c. Self-Expanding Cork: Comply with ASTM D1752.
    d. Comply with ASTM D1751.

B. Reinforcement:

1. Reinforcing Steel and Wire Fabric: As specified in Section 03 20 00 "Concrete Reinforcing".

2. Deformed Reinforcing:

    a. Steel: Comply with ASTM A615.
    b. Yield Grade: 40 ksi
    c. Billet Bars: Deformed.
    d. Finish: Uncoated.

3. Deformed Bar Mats:

    a. Description: Steel bars.
    b. Comply with ASTM A184.
    c. Fabrication: Comply with ASTM A615.
    d. Yield Strength: 40 ksi.
    e. Finish: Uncoated.

4. Welded Deformed-Wire Fabric:

    a. Comply with ASTM A1064.
    b. Configuration: Flat sheets.

c. Finish: Uncoated.

5. Welded Plain-Wire Fabric:

a. Comply with ASTM A1064.
b. Configuration: Flat sheets.
c. Finish: Uncoated.

6. Dowels:

a. Description: Plain steel bars.
b. Comply with ASTM A615.
c. Yield Strength: 40 ksi.
d. Length: As indicated on Drawings.
e. Ends: Square, with burrs removed.
f. Finish: Uncoated.

7. Tie Wire:

a. Type: Annealed.
b. Minimum Size: 16 gauge.
c. Finish: Uncoated.

8. Epoxy Coating Patching Material: Type as recommended by coating manufacturer.

C. Concrete:

1. Concrete Materials:

a. As specified in Section 03 30 00 "Cast-in-Place Concrete”

2. Cement:

a. Comply with ASTM C150.
b. Type: I - Normal portland.
c. Color: Gray.

3. Fine and Coarse Aggregates:

a. Pit Run, Washed, 3/8 Inch Stone; Free Of Shale, Clay, Friable Material And Debris.

2.5 MIXES

A. Concrete:

1. Comply with ASTM C94/C94M

B. Concrete Mix:

1. Mix and deliver concrete according to ASTM C94, Option B.

2. Mix concrete according to ACI 304 and deliver concrete according to ASTM C94.
3. Mix Design:

a. Compressive Strength:
1) 28 Day: 4,000 psi

2.6 ACCESSORIES

A. Curing Compound, Type 1:

1. Comply with ASTM C309.
2. Type: 1.
3. Class: A.

B. Liquid Surface Sealer: Topical, Type 1, Class A According To ASTM C135,as manufactured by.

C. Joint Sealers:

1. Hot Applied:

a. Comply with ASTM D6690.

2. Cold Applied: Comply with ASTM C920.

2.7 SOURCE QUALITY CONTROL

A. Testing: Comply with ASTM C94/C94M

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that compacted subgrade is dry.

B. Verify that gradients and elevations of subgrade are as indicated on Drawings.

C. Verify reinforcing placement for proper size, spacing, location, and support.

3.2 PREPARATION

A. Moisten substrate to minimize absorption of water from fresh concrete.

3.3 INSTALLATION OF SIDEWALKS

A. Subgrade:

1. As specified in Section 31 05 16 "AGGREGATES FOR EARTHWORK".

B. Forms:

1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
3. Clean forms and coat with form oil each time before concrete is placed.
4. Wood Forms: Thoroughly wet with water before concrete is placed.

C. Reinforcement:

1. Place reinforcing at mid-height of paving.
2. Place reinforcing as indicated on Drawings.
3. Interrupt reinforcing at contraction joints.
4. Place dowels to achieve indicated paving alignment.

D. Placing Concrete:

1. As specified in Section 03 30 00 "Cast-in-Place Concrete".
2. Use slip-form technique.
3. Place concrete in forms in one layer.
4. Ensure that reinforcing, inserts, embedded parts, formed joints, and are not disturbed during concrete placement.
5. Place concrete continuously over full width of panel and between predetermined construction joints.
6. Do not break or interrupt successive pours such that cold joints occur.
7. Consolidate concrete by tamping and vibration.

E. Joints:

1. Place continuous transverse contraction joints at 5-foot intervals or width of sidewalk, whichever is less.
2. Filler:

    a. Place joint filler between paving components and building or other appurtenances.
    b. Recess top of filler 1/4 inch for sealant installation.

3. Provide sawn joints at 3-foot intervals between sidewalks and curbs.
4. Provide keyed joints as indicated on Drawings.
5. Saw-cut contraction joints 3/16 inch wide at optimum time after finishing, cutting one-third into depth of slab.
6. Seal joints as indicated.

F. Finishing:

1. Light broom to 1/8-inch radius, and trowel edges of joints.
2. Texture Direction: Transverse to paving direction.
3. Ramps: Broom perpendicular to slope.

4. Place curing compound on exposed concrete surfaces immediately after finishing.
5. Edges and Joints:

    a. Edger Radius: 1/8 inch.
    b. Spalled Corners and Edges: Clean and fill with mortar mixture and finish.

G. Backfilling: After curing, backfill, grade, and compact adjacent disturbed area as indicated.

3.4 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/2 inch in 10 feet.

B. Maximum Variation from True Position: 1/2 inch.

C. Line and Grade for Forms: 1/2 inch in any 10-foot-long section.

3.5 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Comply with ASTM C94.

2. Samples:

    a. Sampling Procedures: Comply with ASTM C172.
    b. Cylinder Molding and Curing Procedures: Comply with ASTM C31, standard cured.
    c. Sample concrete and make one set of three cylinders for every 75 cu. yd. or less of each class of concrete placed each day, and for every 5,000 sq. ft. of surface area paving.
    d. Make one additional cylinder during cold-weather concreting, and field cure.

3. Cylinder Compressive Strength:

    a. Comply with ASTM C39.
    b. Acceptance:

        1) Average Compressive Strength of Three Consecutive Tests: Maximum 500 psi less than specified compressive strength.

    c. Test one cylinder at seven days, and two cylinders at 28 days.
    d. Retain one cylinder for 60 days for testing when requested by Architect/Engineer.
    e. Dispose of remaining cylinders if testing is not required.

4. Slump, Temperature, and Air Content:

a. Measure for each compressive-strength concrete sample.
b. Slump: Comply with ASTM C143.
c. Air Content: Comply with ASTM C173/C173M
d. Temperature: Comply with ASTM C1064.

5. Records:

a. Maintain records of placed concrete items.
b. Record date, location of pour, quantity, air temperature, number of test samples taken.

3.6 PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, rain and flowing water, and mechanical injury.

B. Do not permit traffic over paving for minimum 7 days after finishing.

C. Damaged Concrete:

1. Remove and reconstruct concrete that has been damaged for entire length between scheduled joints.
2. Refinishing damaged portion is not acceptable.
3. Dispose of damaged portions.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Painted markings applied to asphalt paving.
2. Painted markings applied to concrete surfaces.

B. Related Requirements:

1. Division 32.

1.3 ACTION SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties.

1. Pavement-marking paint, alkyd.
2. Pavement-marking paint, solvent-borne.
3. Pavement-marking paint, acrylic.
4. Pavement-marking paint, latex.
5. Glass beads.

B. Shop Drawings:

1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
2. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Oklahoma City and Oklahoma Department of Transportation for pavement-marking work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain pavement-marking paints from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction and ICC A117.1

2.3 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint, Acrylic: Acrylic, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952F, Type II, with drying time of less than 45 minutes.

1. Color: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to asphalt paving or concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 32 92 23

SODDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Sod.

B. Related Requirements:

1. Division 31 and related sections.

1.3 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area. May include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.4 SUBMITTALS

A. Product Data:

1. Submit sod producer's information for sod grass species.
2. Submit manufacturer information for fertilizer, mulch, and other accessories.

B. Sod Producer's Certificate: Certify that sod grass meets or exceeds specified requirements.

C. Test and Evaluation Reports: Indicate topsoil nutrient and pH levels, with recommended soil supplements and application rates.

D. Source Quality-Control Reports: For sod and accessories.

E. Qualifications Statements: For sod producer, manufacturer, and installer.

F. Submit sod producer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Submit maintenance instructions, cutting method, and maximum grass height.
2. Submit fertilizer types, application frequency, and recommended coverage.

1.6 QUALITY ASSURANCE

A. Sod: Ensure root development capable of supporting its own weight without tearing when suspended vertically by holding upper two corners.

B. Sod Producers Qualifications: Company specializing in products as specified in this Section with minimum three years' experience.

C. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

D. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years'.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver sod.
2. Do not deliver more sod than can be laid within 24 hours.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect exposed roots from dehydration.
3. Provide additional protection according to manufacturer instructions.

1.8 FIELD CONDITIONS

A. Minimum Conditions: Do not place sod when temperature is lower than 32 degrees F.

PART 2 - PRODUCTS

2.1 SOD

A. Description:

1. Cultivated grass sod with strong fibrous root system, free of stones and burned or bare spots.
2. Grade: TPI certified
3. Type: As indicated below.
4. Weed Density: No more than 10 weeds per 1,000 sq. ft.
5. Percentage Grass Type:

    a. BERMUDA GRASS TYPE: 100 Percent.

B. Harvesting of Sod:

1. Machine-cut sod and load on pallets according to TPI.
2. Cut sod in area not exceeding 1 sq. yd., with minimum 1/2-inch and maximum 1-inch topsoil base.

2.2 MATERIALS

A. Topsoil, Option 2:

1. Description: Fertile, agricultural soil typical for locality, capable of sustaining vigorous plant growth, and taken from drained Site.
2. Free of subsoil, clay, impurities, plants, weeds, and roots.
3. pH:

    a. Minimum: 5.4
    b. Maximum: 7.0.

B. Topsoil, Option 3: Excavated from Site and free of weeds.

2.3 ACCESSORIES

A. Fertilizer:

1. Grade: Commercial.
2. Description: As recommended for grass, with 50 percent of elements derived from organic sources.

B. Lime:

1. Description: Agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent.
2. Comply with ASTM C602.

C. Water: Clean, fresh, and free of substances or matter capable of inhibiting vigorous growth of grass.

D. Wood Pegs: Softwood, sufficient size and length to anchor sod on slope.

E. Wire Mesh:

1. Description: Interwoven hexagonal metal wire or plastic mesh.
2. Size: 2 inches.

2.4 SOURCE QUALITY CONTROL

A. Analysis: Ascertain pH and percentage of nitrogen, phosphorus, potash, soluble salt content, and organic matter.

B. Provide recommendation for fertilizer and lime application rates for specified sod grass species based on testing.

C. Prior Tests:

1. Testing is not required if recent tests are available for imported topsoil.
2. Submit such test results to testing laboratory.
3. Indicate, based on test results, information necessary to determine suitability.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that prepared soil base is ready to receive Work of this Section.

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

3.2 INSTALLATION OF SOD

A. Subsoil Preparation:

1. Eliminate uneven areas and low spots.
2. Maintain indicated lines, levels, profiles, and contours.
3. Slopes:

a. Make gradual changes in grade.
b. Blend slopes into level areas.

4. Foreign Materials:

a. Remove foreign materials and undesirable plants and their roots.
b. Do not bury foreign materials beneath areas to be sodded.

5. Remove contaminated subsoil.
6. Scarify subsoil to depth of 4 inches where topsoil is to be placed.
7. Repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

B. Placing of Topsoil:

1. Spread topsoil to minimum depth of 3 inches over area to be sodded.
2. Place topsoil during dry weather and on dry unfrozen subgrade.
3. Remove vegetable matter and foreign nonorganic material from topsoil while spreading.
4. Grade topsoil to eliminate rough, low, or soft areas, and to ensure positive drainage.
5. Install edging at periphery of sodded areas in straight lines to consistent depth.

C. Fertilizing:

1. Apply lime at application rate recommended by soil analysis.
2. Work lime into top 6 inches of soil.
3. Apply fertilizer at application rate recommended by soil analysis.
4. Apply fertilizer after smooth raking of topsoil and prior to installation of sod.
5. Apply fertilizer no more than 48 hours before laying sod.
6. Mix fertilizer thoroughly into upper 4 inches of topsoil.
7. Lightly water soil to aid dissipation of fertilizer.

D. Laying of Sod:

1. Moisten prepared surface immediately prior to laying sod.
2. Lay sod immediately after delivery to Site to prevent deterioration.
3. Joints:

    a. Lay sod tightly with no open joints visible and no overlapping.
    b. Stagger end joints minimum 12 inches.
    c. Do not stretch or overlap sod pieces.

4. Lay smooth and align with adjoining grass areas.
5. Place top elevation of sod 1/2 inch below adjoining curbs and other finished surfaces.

6. Watering:

    a. Water sodded areas immediately after installation.
    b. Saturate sod to 4 inches of soil.

7. Rolling:

    a. After sod and soil have dried, roll sodded areas to bond sod to soil and to remove minor depressions and irregularities.
    b. Roll sodded areas with roller not exceeding 300 lb.
    c. Roll before first watering.

3.3 MAINTENANCE

A. Provide service and maintenance of sodded areas for three months from date of Substantial Completion.

B. Maintain sodded areas immediately after placement until grass is well established and exhibits vigorous growing condition.

C. Mowing:

1. Mow grass at regular intervals to maintain at maximum height of 2-1/2 inches.
2. Do not cut more than 1/3 of grass blade at each mowing.
3. Neatly trim edges and hand-clip where necessary.
4. Immediately remove clippings after mowing and trimming.

D. Water to prevent grass and soil from drying out.

E. Roll surface to remove irregularities.

F. Weed Control:

1. Control growth of weeds by applying herbicides.
2. Remedy damage resulting from improper use of herbicides.

G. Immediately replace sod on areas showing deterioration or bare spots.

H. Protect sodded areas with warning signs during maintenance period.

END OF SECTION

SECTION 33 01 10.58

DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Disinfection chemicals.
2. Neutralizing chemicals.
3. Chlorine residual test kits.

B. Related Requirements:

1. Division 33 specifications.

1.3 ACTION SUBMITTALS

A. Disinfection/Neutralization Procedure:

1. Submit description of procedure, including type of disinfectant and calculations indicating quantities of disinfectants required to produce specified chlorine concentration.
2. Submit description of procedure, including type of disinfectant neutralizing agent and calculations indicating quantities of neutralizing agent required to reduce chlorine content before discharging.

B. Product Data:

1. Disinfection chemicals.
2. Neutralizing chemicals.
3. Chlorine residual test kits.

C. Submit manufacturer information for proposed chemicals and treatment doses.

D. Submit product data per ANSI/AWWA C651, Part III.A.

1.4 INFORMATIONAL SUBMITTALS

A. Certify that final water complies with disinfectant quality standards of City of Oklahoma City.

B. Material Test Reports: For each disinfectant and neutralizing agent, by a qualified testing agency.

C. Field Quality-Control Reports: For disinfection chemicals and neutralizing agents.

D. Qualifications Statements: For manufacturer and installer.

1.5 CLOSEOUT SUBMITTALS

A. Disinfection and Neutralization Reports:

1. Type and form of product(s) used.
2. Date and time of disinfectant injection start and completion.
3. Test locations.
4. Name of person collecting samples.
5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
6. Date and time of flushing start and completion.
7. Disinfectant residual in flushed water in ppm.
8. Disinfectant residual after flushing in ppm for each outlet tested.
9. Chlorine residual in ppm in discharge water.
10. Chlorine neutralization discharge report.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer Qualifications: Company specializing in performing Work of this Section with minimum three years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's packaging; include installation instructions.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store in accordance with manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. 2. Provide additional protection in accordance with manufacturer instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work in accordance with:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 DISINFECTION CHEMICALS

A. Calcium Hypochlorite:

1. Manufacturers:

a. Molekula Group.
b. SCG Process.
c. UnivarSolutions.

2. Comply with AWWA B300.

B. Sodium Hypochlorite:

1. Manufacturers:

a. GFS Chemicals, Inc.
b. Hawkins, Inc.
c. Odyssey Manufacturing CO.

2. Comply with AWWA B300.

C. Ammonium Sulfate:

1. Manufacturers:

a. Adana Chem San A.S.
b. Jost Chemical.
c. Nike Chemical India.

2. Comply with AWWA B302.

D. Sodium Chlorite:

1. Manufacturers:

a. Cargill Incorporated.

b. Nouryon.
c. Wacker Chemie AG.

2. Comply with AWWA B303.

2.3 NEUTRALIZING CHEMICALS

A. Select neutralizing chemical to treat chlorinated water to be discharged, from one of the following chemicals:

1. Ascorbic acid.
2. Sodium ascorbate.
3. Sulfur dioxide.
4. Sodium bisulfate.
5. Sodium sulfite.
6. Sodium thiosulfate.

2.4 CHLORINE RESIDUAL TEST KITS

A. Chlorine Residual Test Kits:

1. Manufacturers:

a. Hach Company.
b. LaMotte.
c. Fisher Scientific.
d. Hellige.

2. Provide high-range chlorine test kits complying with requirements of AWWA Manual M12 "Simplified Procedures for Water Examinations."

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. Verify that piping system has been cleaned, inspected, and pressure tested.

C. Verify that pipe connections and their required access fittings have been installed under Section 33 14 13 "Public Water Utility Distribution Piping" or Section 33 14 16 "Site Water Utility Distribution Piping."

D. Perform scheduling and disinfecting activity with startup, water pressure testing, adjusting and balancing, and demonstration procedures, including coordination with related systems.

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

3.2 INSTALLATION OF DISINFECTION CHEMICALS

A. Provide required chemicals, equipment, and adhesives to perform Work of this Section.

B. In accordance with AWWA C651, provide disinfection of water mains by continuous feed method or tablet/granular method into piping system.

C. Maintain disinfectant in system for 24 hours depending on disinfection method and water temperature.

D. Neutralize, flush, circulate, clean, and repeat until required disinfectant quality standard has been achieved using potable municipal domestic water.

E. Replace permanent system devices that were removed for disinfection.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Coordinate preparation, testing, and discharge with Owner and any other authority having jurisdiction.

C. Disinfection, Flushing, and Sampling:

1. Disinfect pipeline installation in accordance with AWWA C651.
2. Use of liquid chlorine is not permitted.
3. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
4. Disposal:

    a. Legally dispose of chlorinated water.
    b. If dechlorination is required by authority having jurisdiction, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.

5. After final flushing and before pipeline is connected to existing system or placed in service, certify that disinfectant level meets quality standards of authority having jurisdiction.

D. Prepare test, inspection, and discharge reports.

END OF SECTION

SECTION 33 01 30.86

MANHOLE RIM ADJUSTMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manhole frames and covers.
2. Riser rings.

B. Related Requirements:

1. Division 31 and related sections.
2. Section 33 31 00 "Sanitary Sewerage Piping" for execution requirements for sewerage piping as required by this Section.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer information for manhole covers and riser rings construction, features, configuration and dimensions.

B. Qualifications Statements: For manufacturer and installer.

C. Manufacturer's Approval: For installer.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual grade-adjusted elevation of manholes.

1.5 QUALITY ASSURANCE

A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installers Qualifications: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer's instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 MANHOLE FRAMES AND COVERS

A. Manufacturers:

1. EJ.
2. Neenah Foundry Company.

B. Material: Cast iron.

C. Comply with ASTM A48/A48M, Class 30B.

D. Surface: Machined flat bearing.

E. Lid: Removable and lockable.

F. Cover Design: Closed or Open checkerboard grille as indicated.

G. Live Load Rating: H20.

H. Furnish sealing gasket.

I. Cover: Molded with identifying name and logo.

2.3 RISER RINGS

A. Manufacturers:

1. EJ.
2. Neenah Foundry Company.

B. Riser Rings:

1. Thickness of 4 Inches to 6 Inches:

a. Material: Precast concrete.
b. Comply with ASTM C478.

2. Thickness of Less than 4 Inches:

a. Material: Cast iron.
b. Comply with AASHTO M306.

3. Rubber Seal Wraps:

a. Wraps and Band Widths: Comply with ASTM C877, Type III.
b. Cone/Riser Ring Joint: Minimum 3-inch overlap.
c. Frame/Riser Ring Joint: 2-inch overlap.
d. Additional Bands: Overlap upper band by 2 inches.

C. Clay Brick Units:

1. Description:

a. Solid units.
b. Comply with ASTM C32 or AASHTO M91.
c. Grade: SS

2. Nominal Modular Size: 3-5/8” by 2-1/4” by 7-5/8” inches.

3. As specified in Section 04 20 00 "Unit Masonry."
4. As specified in Section 03 41 00 "Precast Structural Concrete."

D. Accessories:

1. Joint Sealant: Comply with ASTM C990.
2. Bolts: Stainless steel; ASTM F593.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.

B. Verify and locate manholes requiring grade adjustment.

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

3.2 INSTALLATION OF MANHOLE FRAMES AND COVERS

A. Raising Manhole Frames and Covers:

1. Locate and raise manholes to grade as indicated on Drawings.
2. Use flat or tapered rubber manhole rings to achieve indicated elevation for frame and cover.
3. Do not adjust elevation greater than 6 inches with rubber manhole rings.
4. Use sealant to seal joints between manhole top, rubber rings, and frame.
5. Reinstall removed manhole frame and cover.

B. Replacing Manhole Frames and Covers:

1. Locate manholes for replacement of frames and covers.
2. Remove existing manhole frames and covers to enable reuse.
3. Deliver removed manhole frames and covers to Owner as maintenance materials.
4. Install new frames and covers for manholes.
5. Adjust new frames and covers to match finished grade as indicated on Drawings.
6. Seal joints between manholes and manhole frames.

C. Paving Restoration: Restore all pavement, sidewalk and concrete areas in accordance with Division 32.

D. Landscaping Restoration: Restore to previous conditions, or in accordance with Section 32 92 23 – Sodding.

END OF SECTION

SECTION 33 05 00

COMMON WORK RESULTS FOR UTILITIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the FAA General Conditions, Special Requirements, the Standard Form of Agreement and Division 01 Specification Sections, apply to this Section, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. Excavating trenches for water lines.
2. Compacted fill from top of utility bedding to subgrade elevations.
3. Backfilling and compaction.

B. Related Sections:

1. Section 01 50 00 – Temporary facilities and controls.
2. Section 31 23 16.13 – Trenching.

1.3 REFERENCES

A. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.4 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

B. Unauthorized Excavation: any excavation beyond the lines and grades indicated on the drawings made by mistake, carelessness, or at the Contractor’s option.

Loose soil disturbed by the teeth of the excavator below the required Subgrade is defined as unauthorized excavation.

C. Authorized Excavation: excavation to the lines and grades indicated on the drawings and also test pits, removing unsuitable material, locating utilities or other uses when directed by the Engineer.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit the proposed method of controlling lines and grades of pipe installation.

C. Submit the proposed equipment and techniques for compaction.

1.6 QUALITY ASSURANCE

A. Comply with standards of authorities having jurisdiction for Utility installations, including materials, installation, and testing.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to installation.

1.8 COORDINATION

A. Section 01 30 00 – Coordination and Administrative Requirements

B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 – PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 LINES AND GRADES

A. Verify that existing conditions are as shown on the Drawings.

B. Lay pipes to lines and grades as required by the contract documents.
   1. Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
   2. Maintain grade alignment of pipe using surveying instruments, laser, or other approved methods.

3.2 PREPARATION

A. Call Oklahoma 811 not less than three working days before performing Work. Comply with all requirements. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum locations.

C. Maintain and protect above and below grade utilities indicated to remain.

D. Establish temporary traffic control in accordance with Section 015000 Temporary Facilities and Controls.

3.3 TRENCHING

A. Remove topsoil and stockpile separately from subsoil.

B. Excavate for utilities to the required lines and grades. All excavation is unclassified and no additional payment will be made regardless of the materials that are encountered.

C. Where aggregate backfill is to be used, load excavated soil directly into trucks and do not stockpile along the trench.

D. Do not advance open trench more than 100-feet ahead of installed pipe.

E. Cut trenches to width indicated on Drawings. Remove water or materials that interfere with Work.

F. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe.

G. Do not interfere with 45 degree bearing splay of foundations.

H. Provide sheeting and shoring to protect excavation as specified in this section.

I. When subsurface materials at bottom of trench are soft, contact Engineer immediately and follow Engineer’s direction for over excavation and backfill.

J. Cut out soft areas of subgrade not capable of compaction in place. Backfill with approved material and compact to density equal to or greater than requirements for subsequent backfill material.

K. Trim excavation. Remove loose matter.

L. Remove excess subsoil not intended for reuse from site.

3.4 TEMPORARY SUPPORT FOR UTILITY POLES

A. Provide temporary support for utility poles where nearby trenching could cause settlement or instability. The decision to provide temporary support and the means and methods of providing support is the responsibility of the Contractor. Consider all factors such as soil conditions, depth of trench, ground water, distance from the pole to the trench, slope of the earth, arrangement of suspended wires, guys, plumbness of the pole, etc.

B. Consult with the Owner of the poles and comply with applicable recommendations or regulations.

C. Temporary support may be provided by the utility company or by the Contractor. Reimburse the utility company for all costs associated with temporary support.

3.5 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Design sheeting and shoring to be removed at completion of excavation work.

C. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

D. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.6 PIPE BEDDING

A. Provide the materials as specified or as detailed on the Drawings.

B. Place initial layer of pipe bedding at the proper grades and elevation required for pipe.

C. Provide recesses or gaps to allow assembly of pipe joints.

D. Place bedding around pipe in layers and fill uniformly on both sides of the pipe to avoid displacing pipe. Fill in layers until bedding extends above pipe as detailed on the Drawings.

3.7 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Place fill material in continuous layers and compact in accordance with the details on the drawings.

D. Employ placement method that does not disturb or damage, utilities in trench.

E. Maintain optimum moisture content of fill materials to attain required compacted density.

F. Do not leave trench open at end of working day, unless directed or otherwise permitted.

G. Protect open trench to prevent danger to the public.

3.8 TOLERANCES

A. Section 31 23 16.13 – Trenching.

B. Top surface of general backfilling: Plus or minus 1-inch from required elevations.

3.9 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements.

B. Perform laboratory material tests in accordance with ASTM D698.

C. Perform in place density tests in accordance with the following:

1. Density Tests: ASTM D2922.
2. Moisture Tests: ASTM D3017.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

E. Frequency of Tests: Up to two per 1,000 feet of trench in select areas only, as determined by the Engineer. Unless field conditions dictate the need, compaction testing is not expected to be required for utility backfilling outside of roadways and shoulders.

3.10 PROTECTION OF FINISHED WORK

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 33 05 61

CONCRETE MANHOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Concrete and masonry manholes.
2. Frames and covers.
3. Riser rings.
4. Pile support systems.

B. Related Requirements:

1. Section 03 10 00 "Concrete Forming and Accessories" for erection and bracing of forms.
2. Section 03 20 00 "Concrete Reinforcing" for reinforcing steel as required by this Section.
3. Section 03 30 00 "Cast-in-Place Concrete" for concrete type for manhole and structure foundation slab construction.
4. Section 31 05 13 "Soils for Earthwork" for soils for backfill in trenches.
5. Section 31 05 16 "Aggregates for Earthwork" for aggregate for backfill in trenches.
6. Section 31 23 16 "Excavation" for excavating for manholes, structures, and foundation slabs.
7. Section 31 23 23 "Fill" for backfilling after manhole and structure installation.
8. Section 33 01 30.86 "Manhole Rim Adjustment" for resetting existing castings and grates.
9. Section 33 31 00 "Sanitary Sewerage Piping" for piping connections to manholes.
10. Section 33 42 00 "Stormwater Conveyance" for piping connections to manholes and structures.

1.3 DEFINITIONS

A. Bedding: A type of specialized material placed under manhole prior to installation and subsequent backfill operations.

1.4 COORDINATION

A. Coordinate Work of this Section with connection to municipal sewer utility service and trenching.

1.5 SUBMITTALS

A. Product Data:

1. Concrete and masonry manholes.
2. Frames and covers.
3. Riser rings.
4. Pile support systems.

B. Shop Drawings:

1. Indicate structure locations and elevations.
2. Indicate sizes and elevations of piping, conduit, and penetrations.
3. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Source Quality-Control Reports: For manholes and covers.

D. Field Quality-Control Reports: For manholes and covers.

E. Qualifications Statement: For manufacturer.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of manholes and connections, and record invert elevations.

1.7 QUALITY ASSURANCE

A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Handling: Comply with precast concrete manufacturer instructions and ASTM C913 for unloading and moving precast manholes and drainage structures.

C. Storage:

1. Store materials according to manufacturer instructions.

2. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
3. Repair property damaged from materials storage.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 FIELD CONDITIONS

A. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry Work.

B. Cold Weather Requirements: Comply with ACI 530/530.1.

1.10 WARRANTY

A. Furnish five-year manufacturer's warranty for concrete manholes.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 CONCRETE AND MASONRY MANHOLES

A. Manufacturers:

1. Armorcast Products Company; brand of Hubbell Utility Solutions; Hubbell Incorporated.
2. Hanson Pipe & Precast.
3. Monarch Products, Inc.
4. Oldcastle Infrastructure Inc.; CRH Americas.

B. Reinforced Precast Concrete Manhole Sections:

1. Comply with ASTM C478.
2. Gaskets: Comply with ASTM C923.
3. Joints:

a. Comply with ASTM C913.
b. Maximum Leakage: 0.025 gal. per hour per foot of joint at 3 feet of head.

C. Reinforced Cast-in-Place Concrete Manhole Sections: As specified in Section 03 30 00 "Cast-in-Place Concrete"

D. Reinforcement:

1. Formed steel reinforcing rods.
2. Thickness: No. 4.
3. Finish: Galvanized.

E. Shaft and Concentric Cone Top Sections:

1. Pipe Sections: Reinforced precast concrete.
2. Joints:

a. Lipped male/female.
b. Dry.

3. Sleeved to receive pipe sections.

F. Shape: Cylindrical

G. Clear Inside Dimensions:

1. As indicated on Drawings.

H. Design Depth:

1. As indicated on Drawings.

I. Clear Cover Opening:

1. As indicated on Drawings.

J. Pipe Entry: Furnish openings as required.

K. Structure Joint Gaskets:

1. Comply with ASTM C361.
2. Material: Rubber.

2.3 FRAMES AND COVERS

A. Manufacturers:

1. EJ.
2. Neenah Foundry Company.

B. Cast iron.

C. Comply with ASTM A48/A48M, Class 30B.

D. Lid:

1. Bearing Surface: Machined flat.
2. Configuration: Removable.
3. Security: Lockable.

E. Cover Design: As required.

F. Live-Load Rating: H20.

G. Furnish sealing gasket.

H. Cover: Molded with identifying name and logo.

I. Grate: Bicycle safe.

J. Nominal Lid or Grate Size: As required.

2.4 RISER RINGS

A. Manufacturers:

1. EJ.
2. Neenah Foundry Company.

B. Riser Rings:

1. Thickness of 4 to 6 Inches:

a. Precast concrete.
b. Comply with ASTM C478.

2. Thickness Less Than 4 Inches:

a. Cast iron.
b. Comply with AASHTO M306.

3. Rubber Seal Wraps:

a. Wraps and Band Widths: Comply with ASTM C877, Type III.
b. Cone/Riser Ring Joint: Minimum 3-inchoverlap.
c. Frame/Riser Ring Joint: 2-inch overlap.
d. Additional Bands: Overlap upper band by 2 inches.

2.5 MATERIALS

A. Cover and Bedding:

1. Bedding: Fill Type as specified in Section 310516 "Aggregates for Earthwork"
2. Cover: Fill Type, as specified in Section 310516 "Aggregates for Earthwork"

2.6 ACCESSORIES

A. Steps:

1. As required by applicable code.
2. Rungs: Formed PP.
3. Fabrication: Formed integral with manhole sections.
4. Diameter: 3/4 inch .
5. Width:

    a. 12 inches.
    b. As indicated on Drawings.

6. Spacing:

    a. 16 inches o.c. vertically, set into structure wall.
    b. As indicated on Drawings.

B. Foundation Slab:

1. Cast-in-place concrete as specified.
2. Precast concrete as specified.
3. Top Surface: Level.

C. Strap Anchors:

1. Shape: Bent steel.
2. Size: 1-1/2 inch wide by ¼ inch thick, length as required.
3. Finish: Galvanized.

D. Joint Sealant: Comply with ASTM C990.

E. Fasteners: Stainless steel; ASTM F593.

F. Geotextile Filter Fabric:

1. As specified in Section 31 05 19.13 "Geotextiles for Earthwork."
2. Non-biodegradable; nonwoven.
3. Comply with AASHTO M288.
4. Class: B.

G. Concrete: As specified in Section 03 30 00 "Cast-in-Place Concrete".

H. Grout: As specified in Section 03 30 00 "Cast-in-Place Concrete".

I. Watertight PE Manhole Insert:

1. Manufacturers:

a. Parson Environmental Products, Inc.

J. Expandable Pipe Plug:

1. Manufacturers:

a. Petersen Products Co.
b. Taylor Made Plastics Inc. (TMP).

K. Soil Backfill from Above Pipe to Finish Grade:

1. Soil Type S1, as specified in Section 31 05 13 "Soils for Earthwork"
2. Subsoil: No frozen earth, or foreign matter, or rocks more than 6 inches in diameter.

2.7 FINISHES

A. Bituminous Interior Manhole Coating:

1. Manufacturers:

a. Polyglass U.S.A., Inc.

2. Description: As specified in Section 09 90 00 "Painting and Coating."

B. Steel Galvanizing:

1. Hot-dip galvanize after fabrication.
2. Comply with ASTM A123.

C. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

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 ground areas for suitable conditions where concrete manholes will be installed.

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

3.2 PREPARATION

A. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

B. Coordinate placement of inlet and outlet pipe or duct sleeves as required by other Sections.

C. Do not install manholes and structures where Site conditions induce loads exceeding structural capacity of manholes or structures.

D. Inspect precast concrete manholes and structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION OF CONCRETE MANHOLES

A. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface structures or utilities in immediate or adjacent areas.

B. Correct over-excavation with fine aggregate.

C. Remove large stones or other hard matter impeding consistent backfilling or compaction.

D. Protect manhole from damage or displacement while backfilling operation is in progress.

E. Excavating:

1. As specified in Section 31 23 16 "Excavation" and in indicated locations and depths.
2. Provide clearance around sidewalls of manhole or structure for construction operations, granular backfill, and placement of geotextile filter fabric.
3. If ground water is encountered, prevent accumulation of water in excavations; place manhole or structure in dry trench.
4. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation as approved by Architect/Engineer.

F. Base and Alignment:

1. Place foundation slab and trowel top surface level.

2. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.
3. Place manhole sections plumb and level, trim to correct elevations, and anchor to foundation slab.
4. Install manholes supported at proper grade and alignment on compacted crushed-stone bedding.
5. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.
6. Form and place manhole or structure cylinders plumb and level, to correct dimensions and elevations.

G. Attachments:

1. As Work progresses, build fabricated metal items.
2. Cut and fit for pipe.
3. Set cover frames and covers level to correct elevations without tipping.

H. Backfilling: As specified in Section 31 05 13 "Soils for Earthwork."

I. Coating: Paint interior with two coats of bituminous interior coating at rate of 120 sq. ft./gal. for each coat.

J. Precast Concrete Manholes:

1. Lift precast components at lifting points designated by manufacturer.
2. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
3. Assembly:

    a. Assemble multisection manholes and structures by lowering each section into excavation.
    b. Install rubber gasket joints between precast sections according to manufacturer recommendations.
    c. Lower, set level, and firmly position base section before placing additional sections.

4. Remove foreign materials from joint surfaces and verify that sealing materials are placed properly.
5. Maintain alignment between sections by using guide devices affixed to lower section.
6. Joint sealing materials may be installed on Site or at manufacturer's plant.
7. Verify that installed manholes and structures meet required alignment and grade.
8. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.
9. Cut pipe flush with interior of structure.
10. Shape inverts through manhole and structures.

K. Cast-in-Place Concrete Manholes:

1. Bear firmly and fully on compacted crushed stone bedding.

2. Erect and brace forms against movement as specified in Section 03 10 00 "Concrete Forming and Accessories."
3. Install reinforcing steel as indicated on Drawings and as specified in Section 03 20 00 "Concrete Reinforcing."
4. Place and cure concrete as specified in Section 03 30 00 "Cast-in-Place Concrete."
5. Frames and Covers:

    a. Set frames using mortar and masonry.
    b. Install radially laid concrete brick with 1/4-inch-thick, vertical joints at inside perimeter.
    c. Lay concrete brick in full bed of mortar and completely fill joints.
    d. If more than one course of concrete brick is required, stagger vertical joints.
    e. Set frame and cover 2 inches above finished grade for manholes and structures with covers located within unpaved areas, to allow area to be graded away from cover beginning 1 inch below top surface of frame.

L. Doghouse Manholes and Structures:

1. Stake out location and burial depth of existing sewer line in area of proposed manhole or structure.
2. Carefully excavate around existing sewer line to adequate depth for foundation slab installation.
3. Protect existing pipe from damage.
4. Cut out soft spots and replace with granular fill compacted to 95 percent maximum density.
5. Bear firmly and fully on compacted crushed stone bedding.
6. Install precast concrete manhole or structure around existing pipe according to applicable Paragraphs in this Section.
7. Grout pipe entrances as specified in Section 03 30 00 "Cast-in-Place Concrete"

8. Block upstream flow at existing manhole or structure with expandable plug.
9. Use hydraulic saw to cut existing pipe at manhole or structure entrance and exit and along pipe length at a point halfway up OD on each side of pipe.
10. Bottom half of pipe is to remain as manhole flow channel.
11. Saw cut to smooth finish with top half of pipe flush with interior of manhole or structure.
12. Grout base of manhole or structure to achieve slope to manhole or structure channel as specified in Section 03 30 00 "Cast-in-Place Concrete" and trowel smooth.

M. Sanitary Manhole Drop Connections:

1. Concrete Encasement: Minimum 2 feet outside of manhole.
2. Form channel from pipe drop to sweep into main channel at maximum angle of 30 degrees.
3. As indicated on Drawings.

N. Castings:

1. Set frames using mortar and masonry.

2. Install radially laid concrete brick with 1/4-inch-thick, vertical joints at inside perimeter.
3. Lay concrete brick in full bed of mortar and completely fill joints.
4. If more than one course of concrete brick is required, stagger vertical joints.
5. Set frame and cover 2 inches above finished grade for manholes and other structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Cast-in-Place Concrete: As specified in Section 03 30 00 "Cast-in-Place Concrete".
2. Concrete Manhole Sections: Comply with ASTM C497
3. Concrete manholes will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Vertical Adjustment of Existing Manholes and Structures:

1. As specified in Section 33 01 30.86 "Manhole Rim Adjustment".
2. If required, adjust top elevation of existing manholes and structures to finished grades as indicated on Drawings.
3. Frames, Grates, and Covers:

    a. Remove frames, grates, and covers cleaned of mortar fragments.
    b. Reset to required elevation according to requirements specified for installation of castings.

4. Reinforcing Bars:

    a. Remove concrete without damaging existing vertical reinforcing bars if removal of existing concrete wall is required.
    b. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.

5. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 03 30 00 "Cast-in-Place Concrete".

END OF SECTION

SECTION 33 11 14

DUAL CONTAINMENT PIPING AND APPURTENANCES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Dual containment pipe, fittings, valves, and appurtenances.

B. Related Requirements:

1. Division 31.

1.3 REFERENCES

A. Reference Standards:

1. ASTM D 1784
2. ASTM D 1785
3. ASTM D 1970
4. ASTM D 2467
5. ASTM D 2464
6. ASTM D 2564
7. ASTM D 2855
8. NSF 61
9. NSF 14
10. ASME/ANSI B31.3
11. The system shall meet the minimum requirements of Federal Regulations 40 CFR-280.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Submit shop drawings.

C. Product Data: Submit data indicating pipe material used, pipe accessories, restrained joint details and materials, and linings and coatings.

D. Manufacturer's Instructions:

1. Indicate special procedures required to unload, store, protect, and install Products specified.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 73 00 - Execution: Requirements for submittals.

B. Project Record Documents: Record location of pipe runs, connections, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this Section with minimum three years documented experience.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with this Section and the manufacturer's instructions.

B. Obtain components from a single source having responsibility and accountability to answer and resolve problems regarding proper installation, compatibility, performance, and acceptance.

C. Design, fabricate, and install dual containment piping to meet ASME/ANSI B31.3. Where applicable, manufacturer shall provide thermal stress analysis demonstrating the ability of the dual containment piping system to handle the stated piping conditions with a restrained or a flexible design as follows:

1. Restrained Design

a. The system shall be restrained with no accommodation for inner-pipe movement. Manufacturer should be consulted for the proper location of anchors.

2. Flexible Design

a. The system shall be a flexible design with provisions to allow inner and outer pipe ability to move independent of one another. Anchors will be selectively used to direct thermal expansion into expansion loops, and/or offsets, etc. Manufacturer should be

consulted for the proper location of anchors and expansion compensation design.

1.8 FIELD MEASUREMENTS

A. Verify field measurements and elevations are as indicated.

a. Notify Engineer of specific differences.

B. Verify locations and depths of existing underground lines by excavating test pits at critical locations, including crossings and connection points.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. In accordance with Manufacturer’s recommendations.

1.10 COORDINATION

A. Division 01: Coordination and project conditions

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Asahi/America, Inc. (Pro-Lock)

B. Or approved Equal.

2.2 MATERIALS

A. Product Pipe: Pipe and fittings shall be Polyvinyl Chloride with a Cell Classification of 12454-B in accordance with ASTM D 1784.

B. All Pipe and fittings shall be listed to NSF Standard 61 or health effects portion of NSF Standard 14 Containment Pipe: Same as product pipe.

2.3 PIPE AND PRESSURE RATED FITTINGS

A. Both inner and outer pipes shall conform to requirements for establishing a hydrostatic design basis.

B. Product Pipe Schedule 80 PVC

1. Shall be Schedule 80 PVC Pipe shall be Iron Pipe Size Dimensions manufactured in accordance with ASTM D 1785.

2. Fittings shall be produced in accordance with ASTM D-2467.
3. Product Pipe shall be in sizes 1/2”, 3/4”, 1”, 1-1/2” 2”, 3”, and 4”

C. Containment Pipe Schedule 80 PVC

1. Shall be Schedule 80 PVC Pipe shall be Iron Pipe Size Dimensions manufactured in accordance with ASTM D 1785.
2. Fittings shall be produced in accordance with ASTM D-2467.

D. Product Pipe Schedule 80 CPVC

1. Shall be Schedule 80 CPVC Pipe shall be Iron Pipe Size Dimensions manufactured in accordance with ASTM F 441.
2. Fittings shall be produced in accordance with ASTM F 439.
3. Product Pipe shall be in sizes 1/2”, 3/4”, 1”, 1-1/2” 2”, 3”, and 4”

E. Containment Pipe Schedule 80 CPVC

1. Shall be Schedule 80 CPVC Pipe shall be Iron Pipe Size Dimensions manufactured in accordance with ASTM F 441.
2. Fittings shall be produced in accordance with ASTM F 439.

2.4 UNLISTED COMPONENTS

A. Any special fittings, not supplied as part of the normal product offering, shall be classified as unlisted components. Products falling into this category shall only be supplied by the manufacturer of the dual containment System.

2.5 VALVES

A. Valve arrangements that are to be dual contained shall be supplied pre-assembled. Actuators, stem extensions, and other accessories shall be part of a pre-assembled package where appropriate.

2.6 PIPE SUPPORT DISCS AND GUIDES

A. Supports, guides, etc. for product pipe shall be provided of same resin as product pipe. Supports shall allow axial movement of product pipe within containment pipe. Supports disks shall maintain a concentric relationship between product pipe and containment Support disks shall be designed to allow for an annular space.

2.7 ANCHORS

A. Anchors shall be provided of same resin as product pipe and containment pipe. Anchors shall be of same wall thickness as product and containment pipe, and must be of unitary construction. Anchors shall be fully pressure rated. Anchors shall be DogboneTM style by Asahi/America, Inc. or approved equal.

2.8 VENTS/DRAINS

A. High-point vents and low-point drains shall provide adequate flows to completely drain annular space. Vents/drains shall be located per contract drawings. Vents/drains shall be of same resin as product pipe.

2.9 RIBBON TAPE

A. Description:

1. Type: Detectable for plastic pipe utilities,
2. Material: Polyethylene.
3. Color: Green.
4. Minimum Size: 3 inches by 4 mils thick.
5. Manufacturer for direct burial service.
6. Imprint: utility type in large letters.

a. Industrial waste force main from LS #1, #2, #4 and #7: *INDUSTRIAL WASTE*
b. Cyanide waste force main from LS #3 and #6: *CYANIDE WASTE*

7. Install at depth shown on drawings.

2.10 PIPING IDENTIFICATION

A. Each pipe length and fitting shall be clearly marked with:

1. Manufacturer’s name and trademark.
2. Nominal pipe size and class.
3. Material designation.

B. Provide labels on exposed piping within concrete containment sump indicating service name and flow direction. Labels shall conform to the following:

1. High Temperature, chemical and weather resistant. UV resistant printing laminated between two layers of polyester. Service Temperature up to 240° F.
2. Pipe over 1” size up to 8” size: Wrap-around labels with clear adhesive strip.
3. Flow Direction Arrows: integral with piping-system service lettering to accommodate both directions or as a separate unit on each pipe label to indicate flow direction.
4. Lettering Size: Size letters according to ASME A13.1 for piping.
5. Label Content:

a. Industrial waste force main from LS #1, #2, #4, and #7: INDUSTRIAL WASTE
b. Cyanide Waste forcemain from LS #3 and #6: CYANIDE WASTE

6. Label Color:

a. Industrial waste force main from LS #1, #2, #4, and #7: Green with white lettering.
b. Cyanide Waste forcemain from LS #3 and #6: Red with white lettering.

7. Provide extra labels to the owner, in an equal number as used on piping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 73 00 – Execution: Verification of existing conditions before starting work.

B. Verify trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 BEDDING

A. Excavate pipe trench in accordance with Division 31. Hand trim excavation for accurate placement of pipe to elevations indicated on Drawings.

B. Dewater excavations to maintain dry conditions and preserve final grades at bottom of excavation.

C. Place bedding material in accordance with Section 31 23 33.

3.3 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with Drawings.

B. Install dual containment piping to comply with manufacturer’s recommended procedures.

C. Route piping in straight line.

D. All joining shall be done utilizing a 2 Step process of Primer and cement in accordance with ASTM D2855.

E. Hot gas welding shall not be allowed for wetted components.

F. Manufacturer/Manufacturer’s representative shall be hired by installing firm for on-site training in the assembly, installation, and operation of dual containment systems.

G. Install detectable underground utility marking tape continuous buried 24-inches below finish grade, above pipe line.

H. Record the location and depth of pipe and show on the Record Drawings.

3.4 INSTALLATION - THRUST RESTRAINT

A. For PVC pipe with push-on joints, provide thrust blocks at each fitting.

3.5 FIELD QUALITY CONTROL

A. Pressure Test: Test in accordance with Section 33 38 00.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 73 00 - Execution Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 14 16

SITE WATER UTILITY DISTRIBUTION PIPING

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Piping.
2. Tapping sleeves and valves.
3. Valves and hydrants.
4. Reduced-pressure backflow preventers.
5. Pile support systems.
6. Concrete encasement and cradles.

B. Related Requirements:

1. Section 31 05 13 "Soils for Earthwork" for soils for backfill in trenches.
2. Section 31 05 16 "Aggregates for Earthwork" for aggregate for backfill in trenches.
3. Section 31 23 16 "Excavation" for product and execution requirements for excavation and backfill.
4. Section 31 23 16.13 "Trenching" for execution requirements for trenching.
5. Section 31 23 23 "Fill" for requirements for backfill to be placed by this Section.
6. Section 33 01 10.58 "Disinfection of Water Utility Piping Systems" for disinfection of water mains and appurtenances.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Piping.
2. Tapping sleeves and valves.
3. Valves and hydrants.
4. Reduced-pressure backflow preventers.
5. Pile support systems.
6. Concrete encasement and cradles.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: For piping and related equipment.

B. Qualifications Statements: For manufacturer and installer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer Qualifications: Company specializing in performing Work of this Section with minimum three years' experience in installation of Work of this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
4. Store PE and PVC materials out of sunlight.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.8 WARRANTY

A. Furnish five year manufacturer's warranty for valves.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 PIPING

A. Copper Tubing:

1. Comply with ASTM B88.
2. Type K, annealed.
3. Fittings: ASME B16.18, cast copper
4. Joints: Compression connection or AWS A5.8/A5.8M, BCuP silver braze.

B. PVC Pipe:

1. ASTM D1785, Schedule 40.
2. ASTM D1785, Schedule 80.
3. ASTM D2241.
4. SDR 21 for 200-psig rating.
5. Fittings: PVC, ASTM D2466.
6. Joints:

    a. Comply with ASTM D2855.
    b. Type: Solvent weld.

C. PVC Pipe with Cast Iron Fittings:

1. Comply with AWWA C900, Class 165.
2. Cast Iron Fittings: Comply with AWWA C111.
3. Joints:

    a. Comply with ASTM D3139.
    b. Furnish compression gasket ring.

2.3 TAPPING SLEEVES AND VALVES

A. Tapping Sleeves:

1. Manufacturers:

    a. JCM Industries, Inc
    b. Kennedy Valve Company; a division of McWane, Inc.
    c. Mueller Co. LLC; Mueller Water Products, Inc.
    d. Smith-Blair, a Xylem brand.
    e. U.S. Pipe

2. Material: Ductile or cast iron.
3. Type: Dual compression.
4. Outlet Flange Dimensions and Drilling: Comply with ASME B16.1, Class 125, and MSS SP-60.

B. Tapping Valves:

1. Manufacturers:

a. Mueller Co. LLC; Mueller Water Products, Inc.
b. U.S. Pipe

2. Comply with AWWA C500.
3. Type: Double disc with non-rising stem.
4. Inlet Flanges: Comply with ASME B16.1, Class 125, and MSS SP-60.
5. Mechanical Joint Outlets: Comply with AWWA C111.

2.4 MATERIALS

A. Bedding and Cover:

1. Bedding: Fill Type A1 A2 A3 A4 as specified in Section 31 05 16 "Aggregates for Earthwork".
2. Cover: Fill Type A1 A2 A3 A4 as specified in Section 31 05 16 "Aggregates for Earthwork".
3. Soil Backfill from Above Pipe to Finish Grade:

a. Soil Type S1 S2 as specified in Section 31 05 13 "Soils for Earthwork".
b. Subsoil with no rocks greater than 6 inches in diameter, frozen earth, or foreign matter.

2.5 ACCESSORIES

A. Thrust Restraints: As specified in Section 33 05 09.33 "Thrust Restraint for Utility Piping."

B. Pipe Markers: As specified in Section 33 05 97 "Identification and Signage for Utilities."

C. Steel Rods, Bolt, Lugs, and Brackets:

1. Comply with ASTM A36/A36M or A307.
2. Grade A carbon steel.

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 site water utility distribution piping to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

D. Protect and support existing distribution piping and appurtenances as Work progresses.

3.3 INSTALLATION OF PIPING

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 16.13 "Trenching".

2. Placement:

    a. Place bedding material.
    b. Level fill materials in one continuous layer not exceeding 6 inches of compacted depth.
    c. Compact to 95 percent maximum density.

3. Backfill around sides and to top of pipe with cover fill, tamp in place, and compact to 95 percent maximum density.
4. Backfill around sides and to top of pipe as specified in Section 31 23 23 "Fill."

5. Maintain optimum moisture content of fill material to attain required compaction density.
6. Place fill materials as specified in Section 31 23 23 "Fill."

B. Pipe and Fittings:

1. Maintain separation of water main from sewer piping according to Oklahoma City code.
2. Group piping with other Site piping work whenever practical.
3. Install pipe to elevations indicated on Drawings.
4. Install ductile-iron piping and fittings according to AWWA C600.
5. Install grooved and shouldered pipe joints according to AWWA C606.
6. Route pipe in straight line.
7. Install access fittings to permit disinfection of water system performed under Section "Disinfection of Water Utility Piping Systems"
8. Thrust Restraints:

    a. Form and place concrete for pipe thrust restraints at each elbow or change of pipe direction.

b. Place concrete to permit full access to pipe and pipe accessories.

c. Provide bearing area sufficient for bearing.

9. Establish elevations of buried piping with not less than 2 feet of cover.
10. Pipe Markers: As specified in Division 31 section ”Earthwork”.

C. Disinfection: As specified in Section 33 01 10.58 "Disinfection of Water Utility Piping Systems."

3.4 TOLERANCES

A. Install pipe within tolerance of 5/8 inch.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Pressure test piping system according to AWWA C600.
2. Pressure test piping system as indicated on pipe schedule.
3. Pressure test piping system according to AWWA C600 and following:

a. Test Pressure: Not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater.
b. Conduct hydrostatic test for a minimum of two hours.
c. Slowly fill section to be tested with water; expel air from piping at high points.
d. Install corporation cocks at high points.
e. Close air vents and corporation cocks after air is expelled.
f. Raise pressure to specified test pressure.
g. Observe joints, fittings, and valves under test.
h. Remove and renew cracked pipes, joints, fittings, and valves showing visible leakage, and retest.
i. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
j. Maintain pressure within plus or minus 5 psi of test pressure.
k. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
l. Compute maximum allowable leakage using following formula:

1) L = SD x sqrt(P)/C.
2) L = testing allowance, gph.
3) S = length of pipe tested, feet.
4) D = nominal diameter of pipe, inches.
5) P = average test pressure during hydrostatic test, psig.
6) C = 148,000

m. If pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
n. Leakage:

1) If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
2) Correct visible leaks regardless of quantity of leakage.

4. Compaction Testing:

a. Comply with ASTM D1557 ASTM D698 ASTM D6938.
b. Frequency of Compaction Tests: Perform one field density test for each 300 linear feet of trench per lift, for each material type (bedding, pipe zone, and backfill), or a minimum of one test per lift per day, whichever is greater.
c. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

END OF SECTION

SECTION 33 31 00

SANITARY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sanitary sewerage piping.
2. Manholes.
3. Flexible couplings.
4. Flexible pipe boots for manhole pipe entrances.

B. Related Requirements:

1. Section 31 05 13 "Soils for Earthwork" for soil for backfill in trenches.
2. Section 31 05 16 "Aggregates for Earthwork" for aggregate for backfill in trenches.
3. Section 31 23 16 "Excavation" for requirements for excavation and backfill as required by this Section.
4. Section 31 23 16.13 "Trenching" for requirements for trenching as required by this Section.
5. Section 31 23 23 "Fill" for requirements for backfilling as required by this Section.
6. Section 33 05 61 "Concrete Manholes" for manholes for sanitary sewerage piping.

1.3 DEFINITIONS

A. Bedding: Fill placed under, beside, and directly over pipe, prior to subsequent backfill operations.

1.4 COORDINATION

A. Coordinate Work of this Section with termination of sanitary sewer connection outside building, connection to municipal sewer utility service and trenching.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Sanitary sewerage piping.
2. Manholes.
3. Flexible couplings.
4. Flexible pipe boots for manhole pipe entrances.

1.6 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Reports: For piping and accessories.

B. Field Quality-Control Reports: For piping and accessories.

C. Qualifications Statements: For manufacturer and installer.

1.7 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record finished locations of pipe runs, connections, manholes, cleanouts**,** and invert elevations.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer Qualifications: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:

1. Store materials according to manufacturer instructions.
2. Store valves in shipping containers with labeling in place.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Perform Work according to:

1. The State of Oklahoma Department of Transportation standards.
2. The Municipality of Oklahoma City Department of Public Works standards.
3. Oklahoma City Airport Trust standards.

2.2 SANITARY SEWERAGE PIPING

A. Plastic Pipe with Bell and Spigot End Connections with Solvent-Sealed Ends:

1. Material: PVC.
2. Comply with ASTM D2729.
3. Inside Nominal Diameter: inches.
4. Fittings: PVC.
5. Joints:

    a. Solvent welded with solvent cement conforming to ASTM D2564.
    b. Comply with ASTM D2855.

B. Plastic Pipe with Bell and Spigot End Connections with Rubber-Ring-Sealed Gasket Joint:

1. Material: PVC.
2. Comply with ASTM D3034, SDR-**35**.
3. Inside Nominal Diameter: inches.
4. Fittings: PVC.
5. Joints:

    a. Elastomeric gaskets.
    b. Comply with ASTM F477.

C. Plastic Pipe for Piping Up to 12 Inches in Diameter:

1. Material: PVC, Schedule 40
2. Comply with ASTM D1785.
3. Inside Nominal Diameter: inches.
4. End Connections: Bell and spigot with solvent-sealed ends.
5. Fittings:

    a. Material: PVC.
    b. Comply with ASTM D2466.

6. Joints:

    a. Solvent welded with solvent cement according to ASTM D2564.
    b. Comply with ASTM D2855.

2.3 MANHOLES

A. As specified in Section 33 05 61 "Concrete Manholes."

2.4 COUPLINGS

A. Flexible Couplings:

1. Manufacturers:

   a. Fernco Inc
   b. Romac Industries, Inc.

2. Material: Resilient, chemical-resistant, elastomeric PVC.
3. Attachment: Two stainless-steel clamps, screws, and housings.

2.5 PIPE BOOTS

A. Flexible Pipe Boots for Manhole Pipe Entrances:

1. Manufacturers:

   a. A-LOK Products, Inc.
   b. Press-Seal Corporation

2. Material: EPDM.
3. Comply with ASTM C923.
4. Attachment: stainless-steel clamp and hardware.

2.6 MATERIALS

A. Bedding and Cover:

1. Bedding: As specified in Section 31 05 16 "Aggregates for Earthwork"
2. Cover: Fill Type A1 A2 A3 A4, as specified in Section 31 05 16 "Aggregates for Earthwork".
3. Soil Backfill from Above Pipe to Finish Grade:

   a. Soil Type S1 S2, as specified in Section 31 05 13 "Soils for Earthwork".
   b. Subsoil with no rocks more than 6 inches in diameter, frozen earth, or foreign matter.

2.7 ACCESSORIES

A. Pipe Markers: As specified in Division 31.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that trench cut is ready to receive Work of this Section.

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

3.2 PREPARATION

A. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

B. Correct over-excavation with fine aggregate.

C. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

D. Protect and support existing sewer lines, utilities, and appurtenances.

E. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Architect/Engineer if crossing conflicts occur.

3.3 INSTALLATION OF SANITARY SEWERAGE PIPING

A. Bedding:

1. Excavate pipe trench as specified in Section 12 31 6.13 "Trenching"
2. Place bedding material at trench bottom.
3. Level materials in continuous layer not exceeding 8 inches
4. Maintain optimum moisture content of bedding material to attain required compaction density.

B. Sanitary Sewerage Piping:

1. Install pipe, fittings, and accessories according to ASTM D2321 and seal joints watertight.
2. Lay pipe to slope gradients as indicated on Drawings.
3. Begin at downstream end of system and progress upstream.
4. Bedding:

    a. Install at sides and over top of pipe, to minimum compacted thickness of 12 inches
    b. As indicated on Drawings.

5. Lay bell-and-spigot pipe with bells upstream.
6. Backfill and compact as specified in Section 31 23 16.13 "Trenching."
7. Do not displace or damage pipe when compacting.
8. Connect to building sanitary sewer outlet and municipal sewer system through installed sleeves.
9. Pipe Markers: As specified in Section 33 05 97 "Identification and Signage for Utilities."
10. Install Site sanitary sewage system piping to within 5 feet of building and connect to building sanitary waste system.

C. Backfilling:

1. Backfill around sides and to top of pipe with cover fill in minimum lifts of 6 inches.
2. Tamp fill in place, and compact to 95 percent of maximum density.
3. Place and compact material immediately adjacent to pipes to avoid damage to pipe and prevent pipe misalignment.
4. Maintain optimum moisture content of bedding material as required to attain specified compaction density.
5. As specified in Section 31 23 23 "Fill."

3.4 INSTALLATION OF MANHOLES

A. Manholes: As specified in Section 33 05 61 "Concrete Manholes."

3.5 TOLERANCES

A. Maximum Variation from Indicated Slope: 1/8 inch 10 feet.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Request inspection by inspector prior to and immediately after placing bedding.

C. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
2. Perform testing on Site sanitary sewage system according to local code standards.

D. Prepare test and inspection reports.

3.7 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

B. Cap open ends of piping during periods of Work stoppage.

END OF SECTION

SECTION 33 34 00

UNDERGROUND PRESSURE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe and Fittings.

B. Related Requirements:

1. Division 31.

1.3 REFERENCES

A. ASTM International:

1. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
2. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
3. ASTM D3350 - Standard Specification for Polyethylene (PE) Plastic Pipe and Fittings Material

B. American Water Works Association:

1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Submit shop drawings.

C. Product Data: Submit data indicating pipe material used, pipe accessories, restrained joint details and materials, and linings and coatings.

D. Manufacturer's Instructions:

1. Indicate special procedures required to unload, store, protect, and install Products specified.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 73 00 - Execution: Requirements for submittals.

B. Project Record Documents: Record location of pipe runs, connections, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing work of this Section with minimum three years documented experience.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with this Section and the manufacturer’s instructions.

1.8 FIELD MEASUREMENTS

A. Verify field measurements and elevations are as indicated.

1. Notify Engineer of specific differences.

B. Verify locations and depths of existing underground lines by excavating test pits at critical locations, including crossings and connection points.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

1.10 COORDINATION

A. Division 01: Coordination and project conditions

PART 2 - PRODUCTS

2.1 PUMP STATION PIPE

A. Ductile Iron Pipe: AWWA C151

1. All Pipe

a. Pressure Class - 350 psi.
b. Standard outside asphaltic coating
c. Cement lining and seal coat unless specified otherwise
d. Mechanical Joints AWWA C111 except as specified below.
e. Provide joint restraints where indicated or specified.

2. Liquid Service

a. Standard cement mortar lining with seal coat
b. Standard resilient gaskets

B. Ductile Iron Fittings:

1. AWWA C110; - 350 psi pressure rating.
2. Coating, lining, and gaskets as specified above for Ductile Iron Pipe.

C. PVC Pressure Sewer Pipe and Fittings

1. 12” Nominal Pipe Size and Smaller: AWWA C-900
2. 14” Nominal Pipe Size and Larger: AWWA C905
3. DR-18, 235 PSI rating.
4. Use Ductile Iron Fittings with mechanical joints
5. Provide joint restraints where indicated or specified

PART 3

3.1 JOINT RESTRAINTS

A. Restraints for push-on joints within 40 feet of fitting or valve: Restraining gasket with serrated wedges impregnated into the gasket.

1. U.S. Pipe – Field Lok
2. Or approved equal.
3. Substitutions: Sections 01 25 00 Substitution Procedures.

B. Restrained Polyethylene Pipe Connection for connecting HDPE pipe to Ductile iron Mechanical Joint fittings and valves:

1. Ebaa Iron – HDPE Restraint, Series 2000PV.
2. Or approved equal.
3. Substitutions: Section 01 25 00 – Substitution Procedures.

PART 4 - EXECUTION

4.1 EXAMINATION

A. Section 01 73 00 – Execution: Verification of existing conditions before starting work.

B. Verify trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

4.2 BEDDING

A. Excavate pipe trench in accordance with Division 31. Hand trim excavation for accurate placement of pipe to elevations indicated on Drawings.

B. Dewater excavations to maintain dry conditions and preserve final grades at bottom of excavation.

C. Place bedding material in accordance with Section 31 23 33.

4.3 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with Drawings.

B. Route piping in straight line.

C. Record the location and depth of pipe in 50-foot intervals and show on the Record Drawings.

4.4 INSTALLATION - THRUST RESTRAINT

A. For ductile iron pipe, provide restrained joints at each fitting and for every pipe joint within 25-feet of fittings.

B. For PVC pipe with push-on joints, provide thrust blocks at each fitting.

4.5 INSTALLATION - CRADLES AND ENCASEMENT

A. Provide concrete cradles and encasement for pipeline where indicated on Drawings.

4.6 FIELD QUALITY CONTROL

A. Pressure Test: Test in accordance with Section 33 38 00.

4.7 PROTECTION OF FINISHED WORK

A. Section 01 73 00 - Execution Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 36 14

DUAL CONTAINMENT FIBERGLASS LIFT STATION

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Dual containment fiberglass wetwell.

B. Related Requirements:

1. Division 31
2. Section 33 05 00 – Common Work Results of Utilities
3. Section 33 31 13 –Sanitary Sewerage Utility Piping
4. Division 26
5. Division 43
6. Division 44
7. Drawing Sheet C-103, C-201, C-202, C-601

1.3 REFERENCES

A. Reference Standards:

1. ASTM D3299 Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion Resistant Tanks

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Manufacturer's catalog cuts, specifications, recommended methods of installation.
2. Dimensional drawings.
3. Station layout drawings.
4. Assembly and foundation drawings.
5. List of installation of at least 10 stations of similar design and size which have been operating for over five (5) years, specifically for wastewater.

C. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for approval.

D. Contractor shall submit wetwell fabrication plans and calculations for approval.

E. Contractor shall submit method of connection for each pipe to the proposed wetwell along with plans detailing proposed connections.

F. Manufacturer's Instructions:

1. Indicate special procedures required to unload, store, protect, and install Products specified.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 73 00 - Execution: Requirements for submittals.

B. Project Record Documents: Record actual locations of pumping station.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum fifteen years experience.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with this Section and the manufacturer’s instructions.

B. All wetwells of similar design supplied under this contract shall be the product of a single manufacturer.

1.8 QUALITY CONTROL

A. Each completed wetwell shall be examined for dimensional requirements, hardness, and workmanship. All required ASTM D3299 testing shall be completed, and records of all testing shall be kept and copies of test records shall be presented to customer upon formal written request within a reasonable time period.

1.9 CERTIFICATIONS

A. As a basis of acceptance, the manufacturer shall provide an independent certification which consist of a copy of the manufacturer’s test report and accompanied by a copy of the test results that the wetwell has been sampled, tested, and inspected in accordance with the provisions of this specification and meets all requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. In accordance with Manufacturer’s recommendations.

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

1. Support basin with nylon strings connected to structural lift points during handling.
2. Storage:

a. Store materials according to manufacturer's instructions.
b. Store sensitive materials intended for field assembly in dry area and in original shipping containers.
c. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Provide additional protection according to manufacturer instructions.

1.11 COORDINATION

A. Division 01: Coordination and project conditions

1.12 WARRANTY

A. The wetwell shall be warranted to be free from defects in workmanship, design and materials. If any part of the wetwell should fail during the warranty period, it shall be replaced and restored to service at no expense to the Owner

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Fiberglass reinforced polyester wetwells shall be manufactured from commercial grade polyester resin or vinyl ester resin, with fiberglass reinforcements. The resin system shall be suitable for atmospheres containing industrial waste. Provide industrial waste data to the manufacturer prior to the construction of the lift station. The wetwell shall be a one-piece unit manufactured by Premier Production Equipment of Creedmoor, Texas, or an approved equal.

2.2 GENERAL

A. Resin: The resins used shall be a commercial grade unsaturated polyester resin.

B. Reinforcing Materials: The reinforcing materials shall be commercial Grade “E” type glass in the form of mat, continuous roving, and chop roving, roving fabric or

a combination of the above, having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

C. Interior Surfacing Material: If reinforcing materials are used on the surface exposed to the contained substance, it shall be a commercial grade chemical-resistant glass that will provide a suitable bond with the resin and leave a resin rich surface.

D. Exterior Surface: For a UV inhibitor the resin on the exterior surface of the wetwell shall have gray pigment added for a minimum thickness of 0.125 inches.

E. Fillers and Additives: Fillers, when used, shall be inert to the environment and wetwell construction. Sand shall not be accepted as an approved filler. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of this standard. The resulting reinforced-plastic material shall meet the requirements of this specification.

2.3 FABRICATION

A. EXTERIOR SURFACE: The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 1/2 inch in diameter, delamination and fiber show. For a UV inhibitor the resin in the exterior surface of the wetwell shall have gray pigment added for a minimum thickness of 0.125 inches.

B. INTERIOR SURFACE: The interior surface shall be resin rich with no exposed fibers. The surface shall be free of grazing, delamination, and blisters larger than 1/2 inch in diameter, and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to 6 square feet if they are less than 3/4 inch in diameter and less than 1/16 inch deep.

C. FIBERGLASS REINFORCED BOTTOM: The bottom to be fabricated using fiberglass material as stated in section 2.02. Material and installation to meet all physical requirements as per section A.4. Bottom to be attached to wetwell pipe with fiberglass layup to comply with A.S.T.M.-D3299 specifications. When reinforcement is necessary for strength, the reinforcement shall be fiberglass channel laminated to wetwell bottom per A.S.T.M.-D3299.

D. INTEGRAL INTERNAL FIBERGLASS FILLET: Fiberglass wetwells may have an internal sloped fillet bottom. The fillet shall be constructed of same fiberglass material as the wetwell and shall be lateral to the wetwell. The fiberglass fillet shall have a 1:1 slope and shall not interfere with suction pipe mounting in the wetwell.

E. FIBERGLASS REINFORCED TOP: The fiberglass wetwell top shall be fabricated using fiberglass material as stated in section 2.02. Material and installation to meet all physical requirements as per section 2.04. Top to be attached to wetwell pipe with fiberglass layup to comply with A.S.T.M.-D3299 specifications. When

reinforcement is necessary for strength, the reinforcement shall be fiberglass channel laminated to wetwell bottom per A.S.T.M.-D3299.

F. INSTALLATION OF STUBOUTS: Stub outs shall be cast into the structure by the manufacturer.

G. DEFECTS NOT PERMITTED:

1. Exposed fibers: glass fibers not wet out with resin.
2. Resin runs: runs of resin and sand on the surface.
3. Dry areas: areas with glass not wet out with resin.
4. Delamination: separation in the laminate.
5. Blisters: light colored areas larger than 1/2 inch in diameter.
6. Crazing: cracks caused by sharp objects.
7. Pits or Voids: air pockets.
8. Wrinkles: smooth irregularities in the surface.
9. Sharp projection: fiber or resin projections necessitating gloves for handling.

2.4 PHYSICAL REQUIREMENTS

A. Repairs: All wetwell repairs by the manufacturer shall result in a product which meets all requirements of this specification. Field repair of wetwells will not be allowed.

B. Load Rating: The complete wetwell shall have a minimum dynamic-load rating of 16,000 lbf. when tested in accordance with section 2.05. To establish this rating the complete wetwell shall not leak, crack, or suffer other damage when load tested to 40,000 lbf. and shall not deflect vertically downward more than 0.25 inch at the point of the load application when loaded to 24,000 lb.

C. Stiffness: The wetwell cylinder shall have the minimum pipe-stiffness value shown in table below when tested in accordance with section 2.05

HEIGHT - FT.	**F/AY - PSI**
10 to 20	2.01
21 to 30	3.02
31 to 40	5.24

D. Physical Properties:

	Hoop Direction	**Axial Direction**
1. Tensile Strength (psi)	18,000	5,000
2. Tensile Modules (psi)	0.8×10^6	0.7×10^6
3. Flexural Strength (psi)	26,000	4,500
4. Flexural Modules (psi) (w/ ribs)	0.7×10^6	0.7×10^6

2.5 TEST METHODS

A. TEST METHODS: Tests shall be performed as specified in A.S.T.M.-D3753 latest edition, Section 8.

2.6 MARKING AND IDENTIFICATION

A. Each wet well shall be marked on the inside and outside with the following information:

1. Manufacturer’s name or trademark
2. Manufacturer’s factory location
3. Manufacturer’s serial number
4. Total height and nominal diameter
5. Complies with ASTM D-3299

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 73 00 – Execution: Verification of existing conditions before starting work.

B. Verify that inlet and discharge piping connections are size, location, and elevation as indicated on Drawings.

3.2 PREPARATION

A. Protect piping system from entry of foreign materials and water by using temporary covers, completing sections of Work, and isolating parts of completed system.

3.3 EXCAVATION

A. GENERAL: The limit of excavation shall be such to allow for placing and removing forms, installing sheeting, shoring, bracing, etc. The Contractor shall pile excavated material in a manner that will not endanger the work and will avoid obstructing sidewalks, driveways, power poles, etc. Drainage shall be kept clear.

B. VERTICAL SIDES: When necessary to protect existing or proposed structures or other improvements, the Contractor shall maintain vertical sides of the excavation. The limit shall not exceed three feet outside the footing on a vertical plane parallel to the footing except where specifically approved otherwise by the Engineer. The Contractor shall provide and install any sheeting, shoring, and bracing as necessary to provide a safe work area as required to protect workmen, structures, equipment, power poles, etc. The Contractor shall be responsible for the design and adequacy of all sheeting, shoring, and bracing.

The sheeting, shoring, and bracing shall be removed as the excavation is backfilled in such a manner as to prevent injurious caving.

C. SLOPING SIDES: Where sufficient space is available, the Contractor shall be allowed to back slope the sides of the excavation. The back slope shall be such that the excavation shall be safe from caving. The type of material being excavated shall govern the back slope used, but in any case the back slope shall be no steeper than 1 foot horizontal to 1 foot vertical.

D. DEWATERING: The Contractor shall keep the excavation free from water by use of cofferdams, bailing, pumping, well pointing, or any combination as the situation may warrant. All dewatering devices shall be installed in such a manner as to provide clearance for construction, removal of forms, and inspection of exterior of form work. It is the intent of these specifications that the foundation be placed on a firm dry bed. The foundation bed shall be kept in a dewatered condition a sufficient period of time to ensure the safety of the structure. All dewatering methods and procedures are subject to the approval of the Engineer. The excavation shall be protected from excessive rainfall, drainage and drying. The excavation shall be inspected and approved by the Engineer before work on the structure is started. It is the intent of these specifications that the Contractor provide a relatively smooth, firm foundation bed for footings and slabs that bear directly on the undisturbed earth without additional cost to the Owner, regardless of the soil conditions encountered. The Engineer will be the sole judge as to whether these conditions have been met. The contractor shall pile excavated material in a manner that will not endanger the work.

Water removed from the lift station pit and trenches during demolition and replacement shall be containerized and disposed at Hangar 9 Lift Station #4. Water removed shall be sufficiently filtered to remove excess suspended solids and sediment prior to disposal at Lift Station #4. Any water removed from trenches or lift station pit excavations shall not be discharged to the land surface or storm drains.

E. UNAUTHORIZED OVER EXCAVATION: Excavation for slabs, footings, etc., that bear on earth shall not be carried below the elevation shown on the plans. In the event the excavation is carried on below the indicated elevation, the Contractor shall bring the slab, footing, etc., to the required grade by filling with concrete having a minimum compressive strength of at least 4,000 psi at 28 days.

3.4 HANDLING:

A. Do not drop or impact the wetwell.

B. Wetwells shall be chocked if stored horizontally.

C. If wetwells must be moved by rolling, the ground transversed shall be smooth and free of rocks, debris, etc.

D. FRP wetwells may be lifted by the installation of two lifting lugs as specified by the manufacturer on the outside surface near the top or by a sling or "choker"

connection around the center. Use of chains or cables in contact with the wetwell surface is prohibited.

E. Wetwells may be lifted horizontally using one support point.

3.5 INSTALLATION

A. Install wet wells in accordance with Drawings.

B. Install dual containment piping to comply with manufacturer's recommended procedures.

C. Closed Bottom Wet Well Installation:

1. Bottom of excavation should be compacted to 95% Standard Proctor Density.
2. Poured concrete base shall be per the plans.
3. The fiberglass wetwell shall be connected to the concrete base per the project plans.

D. Internal Bottom Ribs:

1. Wetwells with internal bottom stiffening ribs will require that concrete be poured on the inside of the wetwell to a depth equal to that of the stiffening ribs.

E. Interstitial leak Detection:

1. Leak detection port shall be installed in the free space between the inner and outer tanks during manufacturing. A water sensor probe shall be installed inside port to detect water trapped between the two tanks. The water sensor probe shall be connected to an audible and visual alarm.

F. Ballast for Anti-Floatation

1. Contractor to submit buoyancy calculations and ballast design to Engineer for approval. Ballast calculations shall be signed and sealed by a Professional Engineer registered in the state of Oklahoma.

G. Fiberglass Wetwell Top:

1. The fiberglass top shall have a raised fiberglass collar around the hatch opening. The fiberglass top shall be designed to withstand the weight of the concrete reinforced slab to be installed over it as well as traffic loading.

H. Cutouts:

1. Cutouts in wetwell wall is not permitted without the prior approval of Engineer.

I. Installation of IW piping:

1. Field cutting the lift station will not be permitted. All pipe penetrations shall be cast by the manufacturer and shipped with stub outs. Connect to stub outs using couplings specified in the dual containment piping and appurtenances specification.

J. Installation of Discharge Pipe:

1. Discharge piping shall be installed through factory mounted wall sleeve. A link seal system shall be installed between discharge pipe and wall sleeve.

K. Backfill:

1. Backfill shall be Certified Low-Strength Material (Flowable Fill) in accordance with Section 31 23 23.

3.6 FIELD QUALITY CONTROL

1. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

2. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

3. Wet Well Testing

1. Testing shall be conducted in accordance with manufacturer's recommendations. The owner shall be notified at the time of test and choose to be present.

2. An Exfiltration test must be performed immediately after the wet well has been backfilled and compacted. Exfiltration shall not exceed 0.0142 gal/hr. per foot diameter per foot depth. The test must be done by plugging the gravity invert and filling up the wet well with water to either 1-foot below the wet well top slab, or up to the manhole lid with the lowest elevation below top slab. (This level must be clearly temporarily marked in the wet well internal wall). Once the wet well is filled, it must be left for stabilization for 48 hours minimum prior to beginning the Exfiltration test. Any losses of water within a 30 minute period after filling shall constitute an unsuccessful test. The test shall be done for two hours minimum, and no water may be added to the wet well during the test period. The Exfiltration test must be determine by measuring the amount of water required to raise the wet well level back to the mark at the end of the test period. The maximum allowable water loss to pass the test is determined by the following equation:

Water Loss (gallons) = 0.0142tDh

Where:
t = test time period (2 hours)
D = wet well diameter (in feet)
H = water level depth within wet well (in feet)

If the Exfiltration test fails, the Contractor shall take all the necessary corrective actions to reduce the exfiltration. Once the repairs are completed, the test shall be repeated. The wet well will pass the test when the exfiltration is equal or less than the allowable water loss. The City Inspector shall witness the complete Exfiltration test.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 73 00 - Execution Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 38 00

PIPING SYSTEMS TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Testing Manholes:

    a. Vacuum Test.

2. Testing Gravity Sewer Piping:

    a. Low-pressure Air Test.

3. Hydrostatic Testing Pressure Piping.
4. Leakage Test for Polyethylene Piping.
5. Deflection Testing Plastic Piping.

B. Related Sections:

1. Division 33
2. Division 44

1.3 REFERENCES

A. ASTM International:

1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.
2. ASTM D2122 - Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

B. American Water Works Association:

1. AWWA M55 - PE Pipe Design and Installation

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit the following prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.
4. Provisions for disposal of flushing and test water.
5. Certification of test gauge calibration.
6. Deflection mandrel drawings and calculations.

C. Test Reports: Indicate results of tests.

PART 2 - PRODUCTS

2.1 VACUUM TESTING EQUIPMENT

A. Vacuum pump.

B. Vacuum line.

C. Vacuum tester base with compression band seal and outlet port.

D. Shut-off valve.

E. Stop watch.

F. Plugs.

G. Vacuum gauge, calibrated to 0.1 inch Hg

2.2 AIR TEST EQUIPMENT

A. Air compressor.

B. Air supply line.

C. Shut-off valves.

D. Pressure regulator.

E. Pressure relief valve.

F. Stop watch.

G. Plugs.

H. Pressure gauge, calibrated to 0.1 psi

2.3 HYDROSTATIC TEST EQUIPMENT

A. Hydro pump.

B. Pressure hose.

C. Water meter.

D. Test connections.

E. Pressure relief valve.

F. Pressure gauge, calibrated to 0.1 psi

2.4 LEAKAGE TEST EQUIPMENT

A. Hydro pump.

B. Pressure hose.

C. Pressure relief valve.

D. Pressure gauge, calibrated to 0.1 psi.

2.5 DEFLECTION TEST EQUIPMENT

A. Go, No-Go mandrels.

B. Pull/retrieval ropes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 73 00 – Execution Requirements: Verification of existing conditions before starting work.

B. Verify manholes and piping are ready for testing.

C. Verify trenches are backfilled.

D. Verify pressure piping concrete reaction support blocking or mechanical restraint system is installed.

3.2 PIPING PREPARATION

A. Lamping:

1. Lamp gravity piping after flushing and cleaning.
2. Perform lamping operation by shining light at one end of each pipe section between manholes; observe light at other end; reject pipe not installed with uniform line and grade; remove and reinstall rejected pipe sections; re-clean and lamp until pipe section achieves uniform line and grade.

B. Plug outlets, wye-branches and laterals; brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting.

B. Testing Gravity Sewer Piping:

1. Low-pressure Air Test:

a. Test each section of gravity sewer piping between manholes.
b. Introduce air pressure slowly to approximately 4 psig

1) Determine ground water elevation above spring line of pipe for every foot of ground water above spring line of pipe, increase starting air test pressure by 0.43 psig, do not increase pressure above 10 psig.

c. Allow pressure to stabilize for at least five minutes. Adjust pressure to 3.5 psig or increased test pressure as determined above when ground water is present. Start test.
d. Test:

1) Determine test duration for sewer section with single pipe size from the following table. Do not make allowance for laterals.

AIR TEST TABLE

Minimum Test Time for Various Pipe Sizes

Nominal Pipe Size, Inches	T(time), min/ 100 feet
3	0.2
4	0.3
6	0.7
8	1.2

10	1.5
12	1.8
15	2.1
18	2.4

2) Record drop in pressure during test period; when air pressure has dropped more than 1.0 psig during test period, piping has failed; when 1.0 psig air pressure drop has not occurred during test period, discontinue test and piping is accepted.
3) When piping fails, determine source of air leakage, make corrections and retest; test section in incremental stages until leaks are isolated; after leaks are repaired, retest entire section between manholes.

C. Testing Dual Containment Piping:

1. Dual Containment Hydrostatic Leakage Test:

a. Product Pipe: Hydrostatically test to 150% of operating pressure per ASME B31.3 or per local code.
b. Containment Pipe: The containment piping shall be tested hydrostatically to 150% of operating pressure per ASME B31.3 or per local codes. The product pipe must be pressurized to the same pressure as the test to prevent collapsing of product pipe.
c. Alternate to containment pipe hydrostatic test.
d. To avoid moisture in the containment space, an air test can be conducted on the containment pipe.
e. Pressure test is recommended at 20 psi. The inner carrier pipe shall be full of water and under pressure to avoid any possible collapse. When testing with air, the ambient temperature should be above 40 °F and extra safety precautions for personnel shall be put in place during the test.

D. Testing Underground Pressure Piping and Piping inside Buildings:

1. Hydrostatic Leakage Test:

a. Hydrostatically test each portion of pressure piping, including valved sections. Where test pressures are scheduled on the drawings use the indicated values. Where test pressures are not indicated, test at 1.5 times working pressure of piping based on elevation of lowest point in piping corrected to elevation of test gauge.
b. Fill section to be tested with water slowly, expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled and raise pressure to specified test pressure.
c. Observe joints, fittings and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.

d. Correct visible deficiencies and continue testing at same test pressure for additional 2 hours to determine leakage rate. Maintain pressure within plus or minus 5.0 psig of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.

e. Compute maximum allowable leakage by the following formula:

$$L = \frac{SD\sqrt{P}}{C}$$

L = allowable, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of pipe, in inches
p = average test pressure during leakage test, in psig
C = 133,200

When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

f. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.

E. Leakage Test for Polyethylene Piping.

1. Test completed sections of heat-fused polyethylene pipe before making connections to other materials. Provide heat fused end caps and temporary fittings to add water and expel air. Leave testing connections uncovered to facilitate a visual inspection during test.
2. Test in accordance with AWWA M55. The standard for acceptance for this pipe is zero leakage.

    a. Fill piping and expel air.
    b. Maintain piping full of water and allow time for temperature to equalize.
    c. Pressurize piping to 60 psi and allow 3 hours for initial expansion of the pipe. Add water as required to maintain the pressure. Correct any visible leakage at the testing connections and in the testing apparatus.
    d. Reduce pressure to 50 psi and stop adding water. If the test pressure remains within 3 psi for one hour no leakage is indicated and the pipe test is successful.
    e. If pressurization or testing periods must be interrupted, and the line is allowed to depressurize, remove all pressure and allow the pipe to “relax” for 8 hours.
3. After successful testing, remove testing connections and make connection to other piping.

F. Deflection Testing of Plastic Sewer Pipe:

1. Perform vertical ring deflection testing on PVC sewer piping, after backfilling has been in place for at least 30 days but not longer than 12 months.
2. Allowable maximum deflection for installed plastic sewer pipe limited to 5 percent of original vertical internal diameter.
3. Perform deflection testing using properly sized rigid ball or 'Go, No-Go' mandrel.
4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe as determined by ASTM standard to which pipe is manufactured. Measure pipe in compliance with ASTM D2122.
5. Perform test without mechanical pulling devices.
6. Locate, excavate, replace and retest pipe exceeding allowable deflection.

G. Testing Manholes:

1. General: Test using air whenever possible prior to backfilling to assist in locating leaks. Make joint repairs on both outside and inside of joint to ensure permanent seal. Test manholes with manhole frame set in place.

2. Vacuum test in accordance with ASTM C1244 and as follows:

   a. Plug pipe openings; securely brace plugs and pipe.
   b. Inflate compression band to effect seal between vacuum base and structure; connect vacuum pump to outlet port with valve open; draw vacuum to 10 inches of Hg; close valve; start test.
   c. Test:

      1) Determine test duration for manhole from the following table:

VACUUM TEST TABLE

Manhole Diameter	Test Period
4 feet	60 seconds
5 feet	75 seconds
6 feet	90 seconds

      2) Record vacuum drop during test period; when vacuum drop is greater than 1 inch of Hg during test period, repair and retest manhole; when vacuum drop of 1 inch of Hg does not occur during test period, discontinue test and accept manhole.
      3) When vacuum test fails to meet 1 inch Hg drop in specified time after repair, repair and retest manhole.

H. Prepare reports of testing activities.

END OF SECTION

SECTION 40 05 13

COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Piping and valve identification.
2. Lockout Devices
3. Pipe penetrations for process piping.
4. Restrained joints.
5. Expansion joints.
6. Pipe Couplings.
7. Leakage tests for piping penetrations.

B. Related Requirements:

1. Section 33 38 00 – Piping Systems Testing: Leakage Tests for pressure piping and Low-Pressure Air test for Gravity Sewer Piping.
2. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this Section.
3. Section 09 96 00 – High-Performance Coatings.
4. Section 40 05 13.73 - Plastic Process Piping: Plastic piping materials and appurtenances.

1.3 REFERENCE STANDARDS

A. American Society of Sanitary Engineering:

1. ASSE 1020 - Performance Requirements for Pressure Vacuum Breaker Assembly.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

C. American Water Works Association:

1. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.

D. Expansion Joint Manufacturers Association, Inc.:

1. EJMA Standards.

1.4 COORDINATION

A. Coordinate installation of specified items with piping and equipment installation.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures Submittal procedures.

B. Product Data:

1. Submit manufacturer's catalog information for each product specified.
2. Expansion Joints: Indicate maximum temperature, pressure rating, and expansion compensation.

C. Shop Drawings:

1. Submit list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
2. Indicate restrained joint details and materials being utilized. Submit layout drawings showing piece numbers and locations. Indicate restrained joint locations.
3. Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets, and swing joints.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements

E. Manufacturer's Instructions: Submit special procedures and setting dimensions.

1.6 QUALITY ASSURANCE

A. Perform Work according to ASME Section IX for welding materials and procedures and according to AWS D1.1 for welding procedures used to fabricate pipe.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements for transporting, handling, storing, and protecting products.

B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.9 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls Requirements for ambient condition control facilities for product storage and installation.

B. Do not install underground piping when bedding is wet or frozen.

1.10 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 01 73 00 - Execution and Section 01 77 00 Closeout Requirements for warranties.

B. Furnish one-year manufacturer's warranty for all products.

PART 2 PRODUCTS

2.1 VALVE AND PIPING IDENTIFICATION

A. Valve Tags:

1. Provide plastic or metal tags for all valves listed in the Valve Schedule on the Drawings.
2. Section 46 05 53 – Identification for Water and Wastewater Equipment for Tags.

B. Piping Identification

1. Provide labels on Plastic and Stainless Steel Piping including identification of piping service using same designation and colors as indicated in the Process Piping

Schedule on the Drawings; also include arrows indicating flow direction. Labels shall conform to the following:

a. High Temperature, chemical and weather resistant. UV resistant printing laminated between two layers of polyester. Service Temperature up to 240° F.
b. Pipe up to 1” size: Adhesive backed vinyl cards.
c. Pipe over 1” size up to 8” size: Wrap-around labels with clear adhesive strip.
d. Pipe over 8” size: Strap-On labels with nylon straps.
e. Flow Direction Arrows: integral with piping-system service lettering to accommodate both directions or as a separate unit on each pipe label to indicate flow direction.
f. Lettering Size: Size letters according to ASME A13.1 for piping.

2. Provide extra labels to the owner, in an equal number as used on piping.

2.2 LOCKOUT DEVICES:

A. Valve Operator Covers

1. Provide Polypropylene Lockout Covers, intended to fit over valve operators and accept a padlock to prevent operation of valves during removal or repairs of equipment. Color: Bright Red.

a. Provide two Wheel Valve Lockout Kits, for hand wheel sizes from 1 inch through 13 inch.
b. Provide two Ball Valve Lockout kits, for handles sizes from 3/8” to 8 inch.

B. Chain Wheel Covers

1. Provide split tube covers, designed to surround and immobilize chains, and accept a padlock to prevent operation of valves during removal or repairs of equipment. Color: Bright Red.

a. Provide two cover assemblies.

C. Deliver lockout devices to Owner.

2.3 PIPE PENETRATIONS FOR PROCESS PIPING

A. Wall Pipe: Where indicated on the Drawings, provide ductile iron wall pipe, of the same size as the connecting pipe.

1. Wall pipe shall include a water stop ring at the midpoint.
2. Provide flanges or mechanical joint bells flush with wall as indicated, and provide specially drilled and tapped holes to receive stud bolts to make connection.
3. Protect bolt holes, gaskets, and flange faces during placement of concrete.

B. Sleeves: Where indicated on the Drawings, provide steel pipe sleeves with seal.

1. Sleeves for Pipes through masonry and concrete walls: Minimum Schedule 10 galvanized steel pipe, flush with wall on each end.
2. Sleeves for Pipes through concrete floors: Minimum Schedule 10 galvanized steel pipe, projecting 1 inch above floor surface unless indicated otherwise on the Drawings.
3. Select sleeves to provide a minimum of 1 inch annular space between pipe and sleeve, or sized as required to accommodate Mechanical Seal.
4. Grind ends to provide a smooth exposed surface.
5. Seal

    a. Where indicated on the Drawings, fill annular space with non-shrink grout after completion of piping and connection to equipment.
    b. Where indicated on the Drawings, seal annular space with Modular Mechanical type seal.

C. Core-Drilled Openings

1. Make openings of the proper size to accommodate piping and sealing method as indicated on the drawings.
2. Cut circular openings with a diamond core bit, suitable for cutting concrete and reinforcing.
3. Provide water supply for cooling and flushing
4. Seal

    a. Where indicated on the Drawings, fill annular space with non-shrink grout after completion of piping and connection to equipment.
    b. Where indicated on the Drawings, seal annular space with Mechanical Seal.

D. Mechanical Seals

1. Seals shall consist of interlocking EPDM elastomer elements, pressure plates, and stainless steel bolts linking the elements.
2. Bolts shall cause sealing elements to expand when tightened.
3. Seals shall be rated to withstand a hydrostatic pressure of 20 psi.
4. Select Seals and select sleeve size based on the manufacturer’s recommendation.
5. Install in accordance with the manufacturer’s instructions.

E. Testing

1. Perform leakage test for all piping penetrations through walls of tanks or basins designed to hold sewage or sludge, in accordance Part 3 of this Section.

2.4 PIPE RESTRAINTS

A. Provide tie rods for couplings and expansion joints in Ductile Iron Piping unless indicated otherwise on the drawings. Tie rods shall be as detailed on the Drawings.

B. Provide restrained joints all underground fittings and valves in Ductile Iron Pipe.

C. Mechanical couplings between different pipe materials shall be a restraining type to prevent separation.

2.5 EXPANSION JOINTS

A. Manufacturer: Mercer Rubber or Equal

B. Description

1. Single Arch, Reinforced Butyl Rubber Body.
2. Maximum Temperature: 225 degrees F.
3. Flanged End Connections with backup rings.
4. Control Rods: As specified for Tie Rods in Paragraph 2.4 above.

C. Applications

1. Straight Size: Up to 12” size.

a. Pressure Rating: 250 psi.
b. Axial Compression: 1 ¾”
c. Axial Extension: 7/8”
d. Lateral Deflection: 1”

2. Reducing Sizes: 3x1 to 12x10. Eccentric Reducer Style

a. Pressure Rating: 170 psi in smaller sizes, 140 psi in larger sizes
b. Axial Compression: 1”
c. Axial Extension: 5/8”
d. Lateral Deflection 5/8”

2.6 PIPE COUPLINGS

A. Manufacturer: Ford Meter Box Company, or equal.

B. AWWA C219; ductile iron middle ring; ductile iron followers; wedge section gaskets; stainless steel bolts, AWWA C111 (A21.11).

C. Gaskets: Nitrile rubber (Buna N) or Ethylene propylene diene monomer (EPDM) ASTM D2000; compatible with service conditions.

D. Buried Couplings: Factory epoxy coated.

E. Provide tie rods as specified in Paragraph 2.4 above.

2.7 WATER HAMMER ARRESTORS

A. Manufacturer: Wilkins Model 1250XL-F or equal

B. Requirements:

1. Seamless Copper Tube Body
2. 1” Brass threaded inlet.
3. 34.4 cubic inch air chamber
4. 150 psi working pressure

2.8 PRESSURE GAUGES

A. Manufacturer: Ashcroft Model 1259 or equal.

B. Requirements:

1. 4.5” Dial
2. Ranges as scheduled on the Drawings
3. Accuracy +/- 0.5% full scale
4. Fiberglass reinforced thermoplastic case
5. 316L stainless steel Bourdon tube/socket
6. Liquid filled
7. Connection Size: ½” NPT, stem mounting.
8. Provide with diaphragm seals and snubbers.

2.9 SAMPLE TAP

A. Chrome plated brass with smooth, threadless outlet, ½” size.

2.10 FINISHES

A. Prepare piping appurtenances for field finishes as specified in Division 09.

2.11 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements for testing, inspection, and analysis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 73 00 - Execution and Section 01 77 00 Closeout Requirements for installation examination.

B. Verify that field dimensions are as indicated on Drawings.

C. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flanges mate properly.

D. Verify that openings are ready to receive sleeves.

E. Verify that pipe plain ends to receive sleeve-type couplings are smooth and round for 12 in from pipe ends, and that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

A. Thoroughly clean end connections before installation.

B. Close pipe and equipment openings with caps or plugs during installation.

C. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. Coating: Finish piping appurtenances as specified in Division 09.

B. Piping and Valve Identification: Provide identification at branch connections, equipment inlets and outlets, every 20 ft of straight run, upstream of valves, and within 3 ft of wall entrance and exit.

C. Expansion Joints:

1. Install flexible couplings and expansion joints at connections to equipment and where indicated on Drawings.
2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.

D. Pressure Gauges diaphragm seals shall be filled by a seal assembler certified by the gauge manufacturer.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements.

B. Section 01 73 00 - Execution and Section 01 77 00 Closeout Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to the original coating.

3.5 CLEANING

A. Section 01 73 00 - Execution and Section 01 77 00 Closeout Requirements specifies requirements for cleaning.

B. Keep equipment interior clean as installation progresses.

3.6 TESTING

A. Test pressure piping and gravity sewer piping in accordance with Section 33 38 00.

B. Test piping penetrations in tanks or basins as follows:

1. Fill tank or basin with water to the high water level indicated on the Drawings.
2. Any observable leakage at the penetrations within 24 hours shall be corrected.
3. Correct leaks and retest.

END OF SECTION

SECTION 40 05 13.73

PLASTIC PROCESS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. PVC pipe, tube, and fittings.
2. Polyethylene (PE) pipe, tube, and fittings.
3. Accessories for plastic piping and fittings.

B. Related Requirements:

1. Division 33 - Site Water Utility Distribution Piping: Pipe laying requirements and tolerances, excavation, backfill, and thrust restraints.
2. Section 40 05 13 - Common Work Results for Process Piping: Piping components, appurtenances, and identification requirements common to process piping systems.
3. Section 40 0 523 Process Valves: Common product requirements for valves for placement by this Section.
4. Section 40 05 29 - Hangers and Supports for Process Piping and Equipment: Hangers, anchors, sleeves, and sealing of piping to adjacent structures.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
2. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
3. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
4. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
5. ASME B31.3 - Process Piping Guide.

B. ASTM International:

1. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

2. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
3. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
4. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
5. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
6. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
7. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
8. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
9. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.
10. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
11. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
12. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
13. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
14. ASTM D3892 - Standard Practice for Packaging/Packing of Plastics.
15. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
16. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
17. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
18. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
19. ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing.
20. ASTM F1290 - Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.

C. American Water Works Association:

1. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.
2. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
3. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog information on pipe materials and fittings.

C. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, sizes, and materials lists.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of tests.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 73 00 - Execution and Section 01 77 00 Closeout Requirements: Requirements for submittals.

B. Project Record Documents:

1. Record actual locations of piping, valves and other appurtenances, connections, and elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Perform Work according to referenced standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging according to ASTM D3892.

C. Protect piping and tubing from puncture, abrasion, moisture, and ultraviolet radiation by storing according to manufacturer's recommendations.

1.9 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Temperature: Do not install pipe when temperature is below 40 degrees F or above 90 degrees F if pipe is exposed to direct sunlight.

C. Ultraviolet (UV) Protection: Provide pipe installed above ground or outside with UV protection.

1.10 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 PVC PIPE, TUBE, AND FITTINGS

A. PVC Pipe and Fittings:

1. Pipe: ASTM D1785, Schedule as indicated on piping schedule.
2. Fittings: ASTM D2466, Schedule 40, ASTM D2467, Schedule 80
3. Joints: Socket, solvent-welded, ASTM D2855
4. Materials: ASTM D1784, minimum cell classification 12545-C.
5. Schedule: As indicated on piping schedule.

2.2 PE TUBE AND FITTINGS

A. Polyethylene Tube and Fittings:

1. Tube:

    a. AWWA C901.
    b. Size and Wall Thickness: as indicated on piping schedule.
    c. Pressure Rating: As indicated on piping schedule.

2. Fittings: Compression type; materials suitable for application.
3. Threads: Straight; ASME B1.1.

2.3 FINISHES

A. Coat machined faces of metallic flanges with temporary rust-inhibitive coating.

2.4 ACCESSORIES

A. PVC Piping:

1. Flange Bolting: Stainless steel, ASTM A193 hex head bolts and ASTM A194 hex head nuts.
2. Flange Gaskets: Full faced, ethylene propylene diene monomer (EPDM), according to ASME B16.21.
3. Solvent Cement: ASTM D2564; primers according to ASTM F656.

B. PE Piping:

1. Insert Fittings: ASTM D2609.
2. Couplings: ASTM F1055.
3. Flange Bolting: Stainless steel, ASTM A193 Grade hex head bolts and ASTM A194 Grade hex head nuts.
4. Flange Gaskets: Full faced, EPDM, according to ASME B16.21.

2.5 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 73 00 - Execution and Section 01 77 00 Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Drawings.

C. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Section 01 73 00 - Execution and Section 01 77 00 Closeout Requirements: Requirements for installation preparation.

B. Ream pipe ends. Remove burrs. Bevel plain end pipe.

C. Thoroughly clean pipe and fittings before installation.

D. Surface Preparation:

1. Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. Run piping straight along alignment indicated on Drawings with minimum number of joints.

B. Install piping and components according to ASME B31.3.

C. Fittings:

1. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
2. Install fittings according to manufacturer's instructions.
3. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer's recommendations.

D. Provide required upstream and downstream clearances from devices as indicated.

E. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

F. Support exposed piping as specified in Section 40 05 29 - Hangers and Supports for Process Piping and Equipment.

G. Provide expansion joints as specified in Section 40 051 3 - Common Work Results for Process Piping and pipe guides as specified in Section 40 05 29 - Hangers and Supports for Process Piping and Equipment to compensate for pipe expansion due to temperature differences.

H. Field Cuts: According to pipe manufacturer's recommendations.

I. Joining:

1. Perform heat joining according to ASTM D2657.
2. Perform electrofusion joining according to ASTM F 1290.
3. Primers and Cleaners: ASTM F402.
4. PVC Solvent-Cemented Joints: ASTM D2855.

J. Insulation: As indicated on Drawings.

K. Underground Piping: As specified in Division 31.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by the Engineer. Repair damaged piping, or provide new, undamaged pipe.

C. After installation, inspect for proper supports and interferences.

D. Pressure Testing:

1. According to the following:

a. Test Pressure as indicated on the piping schedule.
b. Conduct hydrostatic test for at least two hours.
c. Fill section to be tested with water slowly; expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
d. Observe joints, fittings, and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
e. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate. Maintain pressure within plus or minus 5 psi of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
f. Compute maximum allowable leakage by the following formula:

L = SD x sqrt(P)/C
L = testing allowance, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of pipe, in inches
P = average test pressure during hydrostatic test, in psig
C = 148,000
When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

g. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.

3.5 CLEANING

A. Section 01 73 00 - Execution and Section 01 77 00 Closeout Requirements specifies requirements for cleaning.

B. Keep pipe interior clean as installation progresses.

C. Clean pipe interior of soil, grit, shavings, and other debris after pipe installation.

END OF SECTION

SECTION 40 91 00

PRIMARY PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

This Section includes general requirements for all instrumentation as shown on the Contract Drawings, and shall apply to all instrumentation furnished on this project, regardless of whether it is specifically identified in this Section. Contractor shall reference the project drawings, including the responsibilities matrix for which contract is responsible to supply, install, wire, terminate, configure, calibrate, integrate, and warranty various equipment throughout the project.

1.3 RELATED DOCUMENTS

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

B. Related Sections

1. Packaged Wastewater Treatment Equipment (46 07 53)

C. CAUTION: Use of this Section without including the above-listed items results in omission of basic requirements.

1.4 REFERENCES

A. Reference Section Packaged Wastewater Treatment Equipment (46 07 53)

1.5 DEFINITIONS

A. Reference Section Packaged Wastewater Treatment Equipment (46 07 53)

1.6 CONTRACTOR QUALIFICATIONS

A. Reference Section Packaged Wastewater Treatment Equipment (46 07 53)

1.7 COORDINATION REQUIREMENTS

A. Instrumentation shall be located, installed, and wired as shown in the Contract Drawings.

B. Materials of construction shall be suitable for the intended application and environment.

C. Reference Section Packaged Wastewater Treatment Equipment (46 07 53)

1.8 SUBMITTALS

A. Reference Section Packaged Wastewater Treatment Equipment (46 07 53)

1.9 DEVIATIONS

A. Reference Section Packaged Wastewater Treatment Equipment (46 07 53)

PART 2 - PRODUCTS

2.1 SCOPE OF WORK

A. Supply all required Submittals as required under the provisions of this Section.

B. Supply, install, wire, terminate, configure, calibrate, integrate, and warranty all instrumentation as indicated in the responsibilities schedule and as shown on the Contract Drawings; to include instruments listed on the instrumentation list

C. Provide five (5) 8-Hour days of on-site training for operators on system operation.

2.2 BASIS OF DESIGN

A. Instrumentation shown on the Process Drawings and as indicated shall be provided as part of the contract.

B. Instrumentation Calibration Range: As indicated.

C. Instrumentation Inputs and Outputs: As indicated.

D. Instrumentation Process Connection: As indicated.

E. Signal isolator/duplicator(s) shall be used for the retransmission of signals to other areas, other locations, other loops, and especially when leaving the building.

F. Signal isolator/duplicator(s) shall be provided as required to ensure adjacent component impedance match where feedback paths may be generated, or to maintain loop integrity during the removal of a loop component.

G. Signal conditioners and converters shall be provided where required to resolve any signal level incompatibilities or provide required functions.

H. In Hazardous (Classified) areas, intrinsic safety barriers (ISB) and conduit with filled seal-offs shall be used for both power and signal wiring and shall provide electrical isolation between the hazardous area and the non-hazardous area.

I. Instruments providing similar function shall be of the same manufacturer and, as much as possible, the same model/series for purposes of parts interchangeability.

J. Instruments shall be new, of the latest design, original, free from defects, and shall have a full manufacturer's new product warranty.

K. Instruments shall be installed in a manner to meet manufacturer's installation and operation requirements.

1. Satisfy manufacturer's proper grounding requirements
2. Satisfy manufacturer's proper unobstructed pipe requirements

    (a) Upstream
    (b) Downstream

3. Satisfy manufacturer's proper instrument orientation requirements
4. Satisfy manufacturer's proper signal cable shielding and isolation requirements
5. Satisfy manufacturer's proper installation and mounting requirements, including all brackets and hardware
6. Provide Sun shield for controllers mounted outdoors

L. Unless otherwise specified, each instrument shall be accurate within 1% of full-scale reading over the calibrated range. This accuracy requirement shall apply to each overall system, including any transmitters, re-transmitters, receivers, etc. that are required.

M. Indicating transmitters are designated by the letter I in the Tag ID (i.e. LIT, PIT) and shall have an integral digital display for indication of real-time process values in scaled Engineering Units (EU).

N. Instruments shall be provided with required probe holders and installation hardware as recommended by the manufacturer for proper operation.

O. Installation mounting hardware, including UniStrut mounting channel, shall be 304 Stainless Steel.

P. All Instrumentation shall be furnished with permanent identification tags attached to the instrument.

1. Instruments shall be identified by the tag shown on the Contract Drawings
2. Identification tags shall be provided on the manufacturer nameplate

(a) Identification tags not provided on the manufacturer nameplate of the instrument shall be laser etched 304 stainless steel tags, attached to the instrument with 304 stainless steel cable.

Q. Any devices, equipment, interfaces, hand-held devices, cables, connectors, and solutions necessary to configure, modify, analyze, and calibrate a supplied transmitter shall be provided with the transmitter and be turned over to the Owner after successful commissioning.

R. Where recommended by the manufacturer, power converters, reactors, or power supplies shall be provided integral with the instrument.

S. Process Instrumentation shall be protected from moisture infiltration.

1. Instrumentation shall be IP67
2. Flexible potting gel shall be provided by the CSI and installed by the Electrical Contractor (EC) prior to operation.

(a) Potting Gel shall remain flexible after installation and shall permit self-healing penetration for verification of electrical signals and connections
(b) Potting Epoxy shall not be permitted.

3. CSI shall provide photo documentation of finished potting gel installation for all instruments.

T. Provide manufacturer’s factory-trained service personnel to perform start-up on instrument, to include, but not limited to:

1. Basic operational training
2. Certification of instrument performance

U. Provide manufacturer’s Service Agreement that provides factory-trained service personnel to perform all the manufacturer’s recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.

V. Use of manufacturer’s service parts and reagents is required.

1. Third-party parts and reagents are not approved for use.

W. Magnetic Flow Meter

1. Manufacturers:

   (a) Rosemount
      (i) *8750W*
   (b) Endress + Hauser
      (i) *Proline Promag*
   (c) Or approved equal.

2. Spare Parts:

   (a) None

3. Maximum measured error: ±0.5%
4. HART Communication Protocol Compliant
5. Fluid to be measured: non-potable, industrial wastewater
6. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.
7. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube.
8. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction and shall produce DC signals directly proportional to the liquid flow rate.
9. Each meter shall be furnished with a stainless steel or carbon steel metering tube and carbon steel flanges with a polyurethane, neoprene, or Teflon liner as required by the application and/or as specified herein.

   (a) Liner shall have a minimum thickness of 0.125 inches.

10. The flow tube shall be provided with Bullet electrodes.

    (a) Ultrasonic electrode cleaning shall not be acceptable.

11. Grounding:

    (a) Integral grounding electrodes shall be provided for all meters under 24 inches in diameter
    (b) Grounding rings shall be provided for all meters equal to or larger than 24 inches in diameter

12. All metallic wetted parts (electrodes, grounding rings, etc.) shall be constructed of 316 stainless steel (minimum), and shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

13. Flow tube shall be rated for, and hydrostatically tested to, pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65°C.
14. Meter and transmitter housings shall meet NEMA 4X requirements as a minimum.
15. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas.
16. Non-metallic transmitter housings shall not be acceptable.
17. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal.
18. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow.
19. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.
20. The transmitter's preamplifier input impedance shall be a minimum of 109-1011 ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.
21. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%).
22. The transmitter's outputs shall be capable of being forced to zero by an external contact operation.
23. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters.
24. Manual calibration of the flow meter shall not be required.
25. Meter configuration parameters shall be stored in non-volatile memory in the transmitter.
26. An output hold feature shall be provided to maintain a constant output during configuration changes.
27. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal.
28. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop.
29. A security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.
30. Accuracy shall be 0.50% of rate over the flow velocity range of 1 to 30ft/sec.

    (a) Optional 0.25% of rate accuracy shall be available.

31. Repeatability shall be 0.1% of rate; minimum turndown shall be 100:1.

32. Minimum required liquid conductivity shall be greater than 5 uS/cm.
33. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum.
34. Transmitter ambient temperature operating limits shall be -10 to +50°C.
35. Power supply shall be 115 VAC, 60 Hz.
36. The transmitter shall be furnished with an option to license for continuous flow meter and system verification and shall be activated as required by the specification or instruments list.
37. The meter verification function shall be internal to the transmitter continuously comparing the transmitters signature values to the measured values from the diagnostic and provide an alert should any measured value be found outside the user defined configurable limits.
38. Flow tubes shall be 150-lb carbon steel flange mounted unless otherwise noted.

    (a) AWWA C207 Table 3 Class D for 30” and larger diameter meters.

39. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer.
40. Transmitter shall be mounted integrally on flow tube, wall, or 2-inch pipe mounted as shown in the Drawings and/or as specified.

X. Gauge Pressure Indicating Transmitter

1. Manufacturers:

    (a) Rosemount
        (i) *2051T*
    (a) Or approved equal.

2. Spare Parts:

    (a) None

3. Gauge pressure transmitters shall be of the piezoresistive type with a process-isolated diaphragm with silicone oil fill, microprocessor-based "smart" electronics, and a field adjustable range ability of 50:1 input range.
4. Span and zero shall be continuously adjustable externally over the entire range.
5. Span and zero adjustments shall be capable of being disabled internally.
6. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low-copper aluminum body and 316 stainless steel process wetted parts.

7. Accuracy, including nonlinearity, hysteresis and repeatability errors shall be plus or minus 0.065 percent of calibrated span, zero based.
8. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits.
9. Output shall be linear isolated 4-20 milliamperes 24VDC.
10. Power supply shall be 24VDC, two-wire design.
11. Each transmitter shall be furnished with a 5-digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required.
12. Overload capacity shall be rated at a minimum of 25 MPa.
13. Environmental limits shall be -40 to 185 Degrees F at 0-100% relative humidity.
14. Each transmitter shall have a stainless steel tag with calibration data attached to body.
15. Configuration of the transmitter may be accomplished using the local display and pushbuttons without the use of an external programming device.
16. The piezoresistive silicon pressure sensor shall be mechanically, electrically, and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing.
17. Factory set correction coefficients shall be stored in the sensor's non-volatile memory for correction and linearization of the sensor output in the electronics section.
18. The electronics section shall correct the digital signal from the sensor and convert it into a 4-20 mA analog signal for transmission to receiving devices.
19. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA output signal, with a remote interface device.
20. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds.
21. Total Long Term Stability (Frequency of Calibration) shall be no less than 0.10% of URL for 3 years.
22. Where scheduled, gauge pressure indicating transmitters shall be calibrated in feet of liquid for liquid level service.

Y. Differential Pressure Indicating Transmitter

1. Manufacturers:

   (a) Rosemount
      (i) *2051C*
   (b) Or approved equal.

2. Spare Parts:

(a) None

3. Differential pressure indicating transmitters shall be the same as the gauge pressure transmitters except for body specifications.
4. Differential pressure units shall be furnished with close coupled stainless steel three valve manifold assembly.
5. The electronics sections of differential pressure transmitters shall contain user-selectable square root extractors to provide a linear 4-20 mA DC output proportional to flow, when activated. Square root extractor circuitry shall be activated on the flow transmitters listed in the Instrument Schedules.
6. Each flow transmitter shall be furnished with laminated flow versus differential pressure curves wall mounted adjacent to the transmitter.
7. Transmitter to be furnished with a 4-digit LCD indicator capable of displaying engineering units, % of output, and/or milliamps and mounting hardware as required.
8. Configuration of the transmitter may be accomplished using the local display and pushbuttons without the use of an external programming device
9. Transmitter shall be factory furnished with an integral 316 stainless steel three valve manifold and instrument mounting bracket.

Z. Pressure Indicating Gauge

1. Manufacturers:

(a) Dwyer
(i) *Model SGY Series*
(a) Or approved equal.

2. Spare Parts:

(a) None

3. Gauges shall have dual psi and bar (x100 kPa) scales with ±1.5% full-scale accuracy.
4. Gauges shall be designed with 304 SS housings and brass wetted parts
5. Gauges shall have bottom or back connections.
6. Gauges shall employ an easy-open breather plug on top
7. Product App Service:

(a) Compatible gases and liquids

8. Wetted Materials:

(a) Brass connection, bronze tube.Housing:304 SS.Lens:Polycarbonate

9. Accuracy:±1.5% FS.
10. Pressure Limit:FS range
11. Temperature Limits:-4 to 140°F (-20 to 60°C).
12. Size:2.5" (63 mm).
13. Process Connections:1/4" male NPT.

AA. Process Analytical Measurement Transmitters (Universal Controller)

1. Manufacturers:

   (a) Hach
      (i) *sc200*
      (ii) *Include HART 7.2 Communication Option*
   (b) Or approved equal.

2. Spare Parts:

   (a) None

3. Door Access Keypad shall satisfy the following requirements:

   (a) Analog Output Functional Mode:

      (i) *Linear, logarithmic, bi-linear, PID*
   (b) Analog Outputs:
      (i) *Two (Five with optional expansion module) isolated current outputs, max 550 Ω, Accuracy:± 0.1% of FS (20mA) at 25 °C, ± 0.5% of FS over -20 °C to 60 °C range*
      (ii) *Operational Mode: measurement or calculated value*
   (c) Communication:
      (i) *MODBUS RS232/RS485*
      (ii) *PROFIBUS DPV1*
      (iii) *HART 7.2*
   (d) Communication Capabilities:
      (i) *Two (2) 4-20mA Out*
   (e) Conduit Openings:
      (i) *1/2 in NPT Conduit*
   (f) Dimensions (H x W x D):
      (i) *144 mm x 144 mm x 181 mm*
   (g) Display Graphic:
      (i) *Dot matrix LCD with LED backlighting, transreflective*
   (h) Display Resolution:
      (i) *240 x 160 pixels*
   (i) Display Size:
      (i) *48 x 68 mm*
   (j) Electrical Certifications:

(i) *EMC*
(ii) *CE compliant for conducted and radiated emissions:*
1. *CISPR 11 (Class A limits)*
2. *EMC Immunity EN 61326-1 (Industrial limits)*
(iii) *Safety*
1. *cETLus safety mark for:*
2. *General Locations per ANSI/UL 61010-1 & CAN/CSA C22.2. No. 61010-1*
3. *Hazardous Location Class I, Division 2, Groups A,B,C & D (Zone 2, Group IIC) per FM 3600 / FM 3611 & CSA C22.2 No. 213 M1987 with approved options and appropriately rated Class I, Division 2 or Zone 2 sensors cULus safety mark*
4. *General Locations per UL 61010-1 & CAN/CSA C22.2. No. 61010-1*

(k) Enclosure Rating:
(i) *IP66 / NEMA 4X*
(l) Length:7.1 in (181 mm)
(m) Manual Languages:
(i) *Bulgarian, Chinese (PRC), Croatian, Czech, Danish, Dutch, English, Estonian, Finnish, French, German, Greek, Hungarian, Italian, Japanese, Korean, Lithuanian, Polish, Portuguese (Brazil), Portuguese (Portugal), Romanian, Russian, Slovak, Slovenian, Spanish, Swedish, Thai, Turkish*
(n) Material Enclosures:
(i) *Polycarbonate*
(ii) *Aluminum (powder coated)*
(iii) *Stainless steel*
(o) Mounting Configurations:
(i) *Wall*
(ii) *Pole*
(iii) *Panel Mounting*

4. Operating Temperature Range:

(a) -20 to 60 °C at 0 to 95% RH (non-condensing)

5. Power Requirements (Hz):

(a) 100 - 240 VAC
(b) 50 - 60 Hz

6. Relay Operational Mode:

   (a) Primary or secondary measurement, calculated value (dual channel only) or timer

7. Relay Functions:

   (a) Scheduler (timer), alarm, feeder control, event control, pulse width modulation, frequency control, and warning

8. Relays:

   (a) Four electromechanical SPDT (Form C) contacts
   (b) 1200 W, 5 A

9. Security Levels:

   (a) 2 password-protected levels

10. Sensor Input #1:

    (a) Analog pH/ORP/DO

11. Sensor Input #2:

    (a) None

12. Storage Conditions:

    (a) -20 °C to 70 °C

13. Warranty:

    (a) 2 years

14. Weight:

    (a) 3.75 lbs. (1.70 kg)

15. Supply the following accessories:

    (a) Sun shield for controllers mounted outdoors
    (b) Mounting hardware

BB. pH Sensor

1. Manufacturers:

   (a) HACH
      (i) *Model pHD-SC pH Sensor*
      (ii) *Include sc200 Controller*
      (iii) *Include Handrail Mounting Hardware*

(b) Or approved equal.

2. Spare Parts:

   (a) pH buffer solutions (pH4, pH7, pH10) for required 6-month replacement – 12 month supply (2 kits of each: pH4, pH7, pH10)
   (b) pH Sensor Standard Cell Solution for required 6-month replacement – 12 month supply (2 kits)
   (c) Salt Bridge for required 6-month replacement – 12 month supply (2 kits)

3. The method of measuring pH will be with a probe or sensor that uses differential electrode measurement technique using three electrodes.

   (a) Two electrodes compare the process value to a stable internal reference standard buffer solution.
   (b) The internal electrode is non-flowing, foul-resistant characteristics.
   (c) Other methods of pH measurement including combination probes will not be accepted.
   (d) Probes or sensors that do not communicate with the Hach model sc200 or sc1000 digital controller will not be accepted.

4. pH Sensor shall consist of the following components:

   (a) Encapsulated sensor with digital signal processor
   (b) Pre-amplifier
   (c) Reference electrode
   (d) Measuring electrode
   (e) Ground electrode
   (f) Replaceable salt bridge.
   (g) Integral 10-meter cable
   (h) Wetted material:
      (i) *PEEK*®
      (ii) *Ryton*®
   (i) pH Probe with built in Pt 1000 RTD temperature compensator
   (j) Salt bridge
   (k) 10-meter integral cable
   (l) Manual

5. The pH analyzer has standard optically isolated analog outputs, selectable as 0/4 to 20mA, field programmable over any portion of the pH analyzer range
6. pH Analyzer shall satisfy the following requirements:

   (a) Measurement range: 0 to 14 pH

(b) Sensitivity: 0.01 pH
(c) Stability: 0.03 pH per 24 hours, non-cumulative
(d) Temperature range: 23 to 158 °F (-5 to 70 °C)
(e) Sample flow rate: 3 meters (10 feet) per second, maximum
(f) Pressure: 100 pounds per square inch at 158 °F (6.9 bar at 70 °C)
(g) Transmission distance:
(i) *100 m (328 ft.), maximum*
(ii) *1000 meters (3240 feet), maximum, requires optional termination box*

7. pH Sensor shall meet the following certifications:

(a) General Purpose CSA/CSANRTL and FM (UL Pending) when used with an approved controller.
(b) Class 1, Div 2 Groups A thru D CSA/CSANTRL and FM (UL Pending) when used with an approved controller.

8. Supply the following accessories:

(a) Air blast cleaning system
(b) Where lengths exceed 100 meters, provide junction box for extension cables and extension cables
(c) ModBUS® RS-232 or RS-485 digital output card
(d) Mounting hardware

CC. ORP Sensor

1. Manufacturers:

(a) HACH
(i) *Model pHD-SC ORP Sensor*
(ii) *Include sc200 Controller*
(iii) *Include Handrail mounting hardware*
(b) Or approved equal.

2. Spare Parts:

(a) ORP Reference solution for required 6-month replacement – 12 month supply (2 kits)
(b) pH buffer solutions (pH4, pH7, pH10) for required 6-month replacement – 12 month supply (2 kits of each: pH4, pH7, pH10)
(c) pH Sensor Standard Cell Solution for required 6-month replacement – 12 month supply (2 kits)
(d) Salt Bridge for required 6-month replacement – 12 month supply (2 kits)

3. The method of measuring ORP will be with a probe or sensor that uses differential electrode measurement technique using three electrodes.

   (a) Two electrodes compare the process value to a stable internal reference standard buffer solution.
   (b) The internal electrode is non-flowing, foul-resistant characteristics.
   (c) Other methods of ORP measurement including combination probes will not be accepted.
   (d) Probes or sensors that do not communicate with the Hach model sc200 or sc1000 digital controller will not be accepted.

4. ORP Sensor shall consist of the following components:

   (a) Encapsulated sensor with digital signal processor
   (b) Pre-amplifier
   (c) Reference electrode
   (d) Measuring electrode
   (e) Ground electrode
   (f) Replaceable salt bridge.
   (g) Integral 10-meter cable
   (h) Wetted material:
      (i) *PEEK®*
      (ii) *Ryton®*
   (i) ORP Probe with built in Pt 1000 RTD temperature sensor
   (j) Salt bridge
   (k) 10-meter integral cable
   (l) Manual

5. The ORP Sensor has standard optically isolated analog outputs, selectable as 0/4 to 20mA, field programmable over any portion of the pH analyzer range
6. ORP Sensor shall satisfy the following requirements:

   (a) Measurement range: -1500 to +1500 mV
   (b) Sensitivity: ±0.5 mV
   (c) Stability: 2 mV per 24 hours, non-cumulative
   (d) Temperature range:
      (i) *Digital Sensor: -5 to 70ºC*
      (ii) *Analog Sensor with Digital Gateway: -5 to 105ºC*
      (iii) *Immersion Sensor: 0 to 50ºC*
   (e) Sample flow rate: 3 meters (10 feet) per second, maximum
   (f) Pressure:
      (i) *Digital: 6.9 bar at 70ºC*
      (ii) *Analog: 6.9 bar at 105ºC*
   (g) Transmission distance:
      (i) *100 m (328 ft.), maximum*

(ii) *1000 meters (3240 feet), maximum, requires optional termination box*

7. ORP Sensor shall meet the following certifications:

   (a) General Purpose CSA/CSANRTL and FM (UL Pending) when used with an approved controller.
   (b) Class 1, Div 2 Groups A thru D CSA/CSANTRL and FM (UL Pending) when used with an approved controller.

8. Supply the following accessories:

   (a) Air blast cleaning system
   (b) Where lengths exceed 100 meters, provide junction box for extension cables and extension cables
   (c) ModBUS® RS-232 or RS-485 digital output card
   (d) Mounting hardware

DD. Float Level Switch

1. Manufacturers:

   (a) Conery
      (i) *2900-B8-S2-C1*
   (b) Flygt
      (i) *ENM-100*
   (c) Or approved equal.

2. Spare Parts:

   (a) None

3. The level sensing device shall be a 3-3/8" diameter, solid polyurethane foam-filled polypropylene float switch.
4. The switch shall be leak-proof, shock-proof, and impact resistant.
5. The switch shall be mercury free.
6. The switch shall be SPDT, rated 10 Amps at 120 VAC or 5 Amps 240VAC non-inductive with a mechanical life of 10 million operations.
7. The float cable shall be rated "continuous service" for high flexibility and shall be 18AWG/3 conductor, Type SJOOW – 300V.
8. The float assembly shall include a zinc-plated cast iron split weight of 1.22lbs to allow for easy adjustment and secure and permanent attachment to the cord.
9. The float shall have both Normally Open and Normally Closed and be configured as Single-Pole, Double-Throw (SPDT) contacts.
10. The float contacts shall change state when the float rises 1” (5°) above horizontal.

11. The weighted 316 SS suspension cable shall be attached via cantilevered 316 SS unistrut and shall have a weighted anchor at the opposite end.
12. The suspension cable and float assembly shall be completely removable from the vessel from above for adjustment, maintenance and replacement, and shall not require the vessel to be empty.
13. The float switch shall be furnished in quantities, cable lengths, and with accessories as shown in the plan drawings.
14. The float switch shall have a 3 year warranty.

EE. Chemical Metering Pump - Peristaltic

1. Manufacturers:

   (a) Liquid Metronics Incorporated (LMI) Milton Roy
      (i) *Model C141-35T*
      (ii) *Include Four-function Valve Accessory 4FV*
   (b) Or approved equal.

2. Spare Parts:

   (a) None

3. Electronic Metering Pumps shall satisfy the following requirements:

   (a) Positive displacement, Liquifram type pumps
   (b) UL, cUL, and CE approved.
   (c) Output volume shall be adjustable while pumps are in operation from zero to maximum capacity of 20 GPH.
   (d) Adjustment shall be by means of readily accessible dial knobs, one for changing stroke length and one for changing stroke frequency. Both knobs are to be located opposite the liquid handling end.
   (e) Drive shaft shall be totally enclosed with no exposed moving parts.
   (f) Solid state electronic pulser shall be fully encapsulated and supplied with quick connect terminals at least 3/16" wide.
   (g) Electronics shall be housed in chemical resistant enclosure at the rear of the pump for maximum protection against chemical spillage. (
   (h) Electrical power consumption shall not exceed 22 watts per hour under full speed and maximum pressure conditions.
   (i) Pump weight shall not exceed 14 lbs.
   (j) To eliminate need for pressure relief valve, Liquifram shall automatically stop pulsating when discharge pressure exceeds pump pressure rating by not more than 35%.

(k) Chemical metering pump housing shall be of chemically resistant glass fiber reinforced thermoplastic.

(l) All exposed fasteners shall be stainless steel. (r) Chemical metering pump valves shall be ball type, with ceramic balls

(i) *(i) Ceramic valve balls seating on Polyprel® or PTFE seats*

(m) Valve seat and seal ring shall be renewable by replacing the combination seat-seal ring or cartridge valve assembly.

(n) Pump head shall be of transparent acrylic material capable of resisting the pumped chemical.

(o) Fittings and connections at pump head shall be PVC

(p) 16 ft of polyethylene tubing shall be provided per pump complete with compression connections.

(q) A foot valve with integral one-piece strainer shall be provided for the suction line.

(r) An injection check/back pressure valve with 1/2" NPT male connection shall be provided for the injection point.

(s) The injection check valve shall incorporate a dilating orifice which prohibits scale formation and accumulation of crystalline deposits.

2.3 PROGRAMMING

A. Any programming or configuration of the instrumentation supplied per this section is the responsibility of the CSI.

2.4 TRAINING

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

B. Train Owner's maintenance personnel for a minimum of 8 hours on procedures and schedules for energizing and de-energizing, troubleshooting, servicing, and maintaining equipment and schedules.

C. Review data in Operation and Maintenance manuals.

2.5 FOLLOW-UP SERVICE

A. Monitoring and Adjusting: After Substantial Completion, but not more than twelve months after Final Acceptance, perform monitoring and adjusting tasks:

B. Replace failed and defective equipment (under warranty).

C. Recalibrate and reconfigure as necessary.

D. Retest and adjust as necessary

2.6 SPARE PARTS

A. All instruments shall be provided with one (1) year of supplies (i.e. charts, pens, ribbons, filaments, sensors, reagents, etc.), spare parts (bulbs, fuses, etc.), and calibration solutions necessary for continuous and accurate operation.

1. This requirement is to be satisfied in addition to any individual section spare parts requirements.

B. Provide 25% spare fuses of each type supplied with the instrument.

END OF SECTION

SECTION 43 23 32

STAINLESS STEEL VERTICAL CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This specification covers stainless steel vertical centrifugal pumps.

B. Pump constructed with all wetted components of 316 stainless steel.

C. Related Specification Sections include but are not necessarily limited to

1. Drawings and general provisions of the Contract, including Special Provisions, apply to work of this section.
2. Division 1 – General Requirements

1.2 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification unless a date is specifically cited.
2. ASME ANSI B 73 – Pump Standards

1.3 SUBMITTALS

A. Conform to bid document requirements.

B. Submittals required after bid and prior to fabrication (for each size pumping unit):

1. Certification of full compliance with specifications.
2. Performance curves (head-capacity, BHP (brake horsepower), NPSH, pump efficiency) covering full operating range from shutoff to run out.
3. Complete materials specifications for each part of unit to be furnished.
4. Dry and wet weight of pump, weight of motor and assembled weight.
5. Construction drawings showing anchor bolt locations, piping details and other pertinent information.
6. Technical bulletins and brochures on pumping unit.
7. Preliminary outline of pumping unit.
8. Drawing of pumping unit showing parts and their materials of construction.
9. Drawings showing pump setting plan including the pump, motor and base.
10. Statement of equipment warranty.
11. Statement of guarantee of pump efficiency, speed (rpm), capacity, head, BHP, and motor horsepower at design point.

12. A guaranteed delivery date for the equipment (which shall be stated as number of calendar days after release date to Manufacturer). Once the order has been placed, the Manufacturer shall notify the Engineer in writing that the pump and motor order has been placed. Notification shall include test date.
13. Base Plate installation procedure and tolerances, including anchor bolt sizing and installation procedure.
14. Motor and pump alignment procedures and tolerances.
15. Lubrication specifications for bearings and for gear coupling.

16. Two (2) year guarantee from the final acceptance date which shall cover both replacement parts and service of the units in the event of failure of the equipment caused by workmanship and materials. Also included shall be the terms and conditions of the warranty.
17. Pump and motor name plate layout.

C. All submittals shall be approved by the Engineer or the Owner prior to delivery.

1.4 QUALITY ASSURANCE

A. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications, and it shall be demonstrated to the satisfaction of the Engineer that the quality is equal to equipment made by that manufacturer specifically named herein.

B. Unit responsibility. The pump manufacturer shall have the single source responsibility for the complete pump-motor-variable controller system. Pump(s), complete with motor with variable speed controller, coupling, necessary guards and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to ensure compatibility and integrity of the individual components, and provide the specified warranty for all components.

C. The vertical centrifugal pump(s) specified in this section shall be furnished by and be the product of one manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Handling, and Storage

1. In accordance with manufacturer’s recommendations.
2. Pumps shall be stored in the Contractor’s staging area. Materials shall not be stored outside the staging area.

1.6 WARRANTY

A. Manufacturer’s Warranty shall be a minimum of two (2) years.

PART 2 - PRODUCTS

2.1 GENERAL

A. Casing and Casing Cover

1. Casing and casing cover shall be constructed of 316 stainless steel.

B. Impeller

1. Impeller shall be constructed of 316 stainless steel.

C. Shaft

1. Shaft shall be 316 stainless steel with a minimum of 1” shaft diameter.

D. Vertical Support Column and Discharge Pipe

1. Discharge pipe shall be 2” 316 stainless steel piping with 316 stainless steel fittings, valves, and appurtenances.

E. Cover Plate

1. To be sized and shaped to fit the sump and furnished from stainless steel. All hardware to be 316 stainless steel.

F. Motor Mounting Bracket

1. To have precision-machined mounting surfaces for a rabbet fit to automatically align pump and motor coupling. The assembly to be designed to house redressable ball bearings for positioning and locking the shaft into position and to allow adjustable impeller clearance without removing the pump from installation. The cast iron motor mounting bracket to be painted with a two-part chemical resistant epoxy resin or similar resistant coating material.

G. Suction Strainer

1. Strainer basket to be provided where required in the same material as the hydraulic head.

H. Factory Testing

1. Each pump to be tested to assure performance at conditions of service. Test data to be permanently recorded and retrievable on request.

I. Manufacturers

1. The manufacturer must comply with this Specification and related Sections.
2. The following manufacturers are acceptable.

a. Weil Pump Co.
b. Or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Engineer shall have the right to inspect all materials and equipment to be furnished under these specifications, prior to their shipment from the point of manufacture.

B. Pump Tests:

1. All pumps shall be factory tested using the job motor operating at full speed.

a. Certified copies of test data and test curve shall be furnished to the Engineer.
b. The efficiency, capacity, and horsepower requirements shall be determined for not less than five points throughout the specified head range from shut-off to maximum capacity. All pumps NPSH required shall be tested.
c. Test procedures, interpretation and conversion of data, shall conform to the latest requirements of the Test Code of Hydraulic Institute.
i. Pump test Acceptance Grade shall be 1U

d. Following completion of shop tests, the Vendor shall furnish to the Engineer for review and approval.

2. Each pump shall have a non-witnessed factory test conducted at the manufacture's facility prior to shipment

a. Performance tests shall be conducted on all fully assembled pumps, with hydraulic conditions similar to those the pumps will experience in the field.
b. Pumps shall be driven by the motors to be supplied with the pumping units.
c. Pumps and motors shall be properly identified so the matched units are installed as tested.

C. Motor Tests:

1. Each motor shall have a non-witnessed factory test conducted at the motor manufactures facility prior to shipment.
2. The actual values of the complete test shall be measured and run in accordance to the applicable provisions for Standard Routine Motor Test Code MG20.46 and the American Test Code.
3. All tests shall be made at the full design voltage unless specified otherwise.
4. All tests will be made in accordance with IEEE #112B and reported on Form G of that manual. Complete test shall include, but not be limited to, the following for each motor rating:

a. No load running current.
b. High potential test.

c. Winding resistance test.
d. Full load heat run.
e. Percent slip.
f. Current balance check.
g. Pull out, starting and breakdown torque.
h. LR current.
i. Efficiency at full, 3/4 and 1/2 load.
j. Power factor at full, 3/4 and 1/2 load.
k. Bearing inspection and temperature recordings.
l. Vibration test.

3.2 INSTALLATION

A. All pumps shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings.

B. Field test shall not be conducted until such time that the entire installation is complete and ready for testing.

C. A certificate from each equipment manufacturer stating that the installation of his equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit shall be submitted.

D. Base Installation

E. The Contractor shall ensure that the pump discharge and suction flange are not supporting the weight of the piping or valves. The motor and pump may be removed for grouting purposes. After grouting is complete and prior to start-up, the motor and pump shall be aligned with a laser device. Prior to installing the coupling, the motor rotation must be verified.

END OF SECTION

SECTION 43 23 33

THERMOPLASTIC VERTICAL CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This specification covers thermoplastic vertical centrifugal pumps.

B. Pump constructed with all wetted components of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP), or polyvinylidene fluoride (PVDF) thermoplastic materials. Flows to 900 GPM. Heads to 180 Ft. Temperatures to 275O F. Sump depths to 20 Ft.

C. Related Specification Sections include but are not necessarily limited to

1. Drawings and general provisions of the Contract, including Special Provisions, apply to work of this section.
2. Division 1 – General Requirements

1.2 REFERENCES

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification unless a date is specifically cited.
2. ASME ANSI B 73 – Pump Standards

1.3 SUBMITTALS

A. Conform to bid document requirements.

B. Submittals required after bid and prior to fabrication (for each size pumping unit):

1. Certification of full compliance with specifications.
2. Performance curves (head-capacity, BHP (brake horsepower), NPSH, pump efficiency) covering full operating range from shutoff to run out.
3. Complete materials specifications for each part of unit to be furnished.
4. Dry and wet weight of pump, weight of motor and assembled weight.
5. Construction drawings showing anchor bolt locations, piping details and other pertinent information.
6. Technical bulletins and brochures on pumping unit.
7. Preliminary outline of pumping unit.
8. Drawing of pumping unit showing parts and their materials of construction.

9. Drawings showing pump setting plan including the pump, motor and base.
10. Statement of equipment warranty.
11. Statement of guarantee of pump efficiency, speed (rpm), capacity, head, BHP, and motor horsepower at design point.
12. A guaranteed delivery date for the equipment (which shall be stated as number of calendar days after release date to Manufacturer). Once the order has been placed, the Manufacturer shall notify the Engineer in writing that the pump and motor order has been placed. Notification shall include test date.
13. Base Plate installation procedure and tolerances, including anchor bolt sizing and installation procedure.
14. Motor and pump alignment procedures and tolerances.
15. Lubrication specifications for bearings and for gear coupling.
16. Two (2) year guarantee from the final acceptance date which shall cover both replacement parts and service of the units in the event of failure of the equipment caused by workmanship and materials. Also included shall be the terms and conditions of the warranty.
17. Pump and motor name plate layout.

C. All submittals shall be approved by the Engineer of the Owner prior to delivery.

1.4 QUALITY ASSURANCE

A. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications, and it shall be demonstrated to the satisfaction of the Engineer that the quality is equal to equipment made by that manufacturer specifically named herein.

B. Unit responsibility. The pump manufacturer shall have the single source responsibility for the complete pump-motor-variable controller system. Pump(s), complete with motor with variable speed controller, coupling, necessary guards and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to ensure compatibility and integrity of the individual components, and provide the specified warranty for all components.

C. The vertical centrifugal pump(s) specified in this section shall be furnished by and be the product of one manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Handling, and Storage

1. In accordance with manufacturer’s recommendations.
2. Pumps shall be stored in the Contractor’s staging area. Materials shall not be stored outside the staging area.

1.6 WARRANTY

A. Manufacturer's Warranty shall be a minimum of two (2) years.

PART 2 PRODUCTS

2.1 MATERIALS

A. Casing and Casing Cover

1. Injection molded homogeneous thermoplastic material selected for compatibility with the fluids being pumped.

B. Impeller

1. Thermoplastic material injection molded with an embedded dynamically balanced stainless-steel insert with radial vanes. It shall be of closed or semi open vane design and have a keyway for mounting on the shaft to assure positive drive.

C. Thermal Fluctuation Modification

1. Casing, impeller, and suction nozzle designed to accommodate temperature fluctuation without change in pump performance.

D. Shaft

1. Stainless steel shaft sleeved with thermoplastic material to isolate it from the fluid and machined at the drive end to fit a flexible coupling. Immersed portion of the shaft to be guided by sleeve bearings consisting of ultra-pure alumina ceramic inner sleeve and Vanite (siliconized graphite) outer sleeve. Bearings to be lubricated by pumped fluid or flushed and lubricated by external water.

E. Vertical Support Column and Discharge Pipe

1. Fabricated of heavy—sectioned thermoplastic. Upper portion of the column to be fitted with a nonmetallic vapor seal to protect motor and ball bearings in mounting bracket.

F. Cover Plate

1. To be sized and shaped to fit the sump and furnished in the same or compatible thermoplastic material as the pump. All hardware below the cover plate to be nonmetallic.

G. Motor Mounting Bracket

1. To have precision-machined mounting surfaces for a rabbet fit to automatically align pump and motor coupling. The assembly to be designed to house redressable ball bearings for positioning and locking the shaft into position and to allow

adjustable impeller clearance without removing the pump from installation. The cast iron motor mounting bracket to be painted with a two-part chemical resistant epoxy resin or similar resistant coating material.

H. Suction Strainer

1. Strainer basket to be provided where required in the same material as the hydraulic head.

I. Factory Testing

1. Each pump to be tested to assure performance at conditions of service. Test data to be permanently recorded and retrievable on request.

J. Manufacturers

1. The manufacturer must comply with this Specification and related Sections.
2. The following manufacturers are acceptable.

a. Vanton Pump and Equipment Corporation.
b. Or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Engineer shall have the right to inspect all materials and equipment to be furnished under these specifications, prior to their shipment from the point of manufacture.

B. Pump Tests:

1. All pumps shall be factory tested using the job motor operating at full speed.

a. Certified copies of test data and test curve shall be furnished to the Engineer.
b. The efficiency, capacity, and horsepower requirements shall be determined for not less than five points throughout the specified head range from shut-off to maximum capacity. All pumps NPSH required shall be tested.
c. Test procedures, interpretation and conversion of data, shall conform to the latest requirements of the Test Code of Hydraulic Institute.
    i. Pump test Acceptance Grade shall be 1U

d. Following completion of shop tests, the Vendor shall furnish to the Engineer for review and approval.

2. Each pump shall have a non-witnessed factory test conducted at the manufacture’s facility prior to shipment

a. Performance tests shall be conducted on all fully assembled pumps, with hydraulic conditions similar to those the pumps will experience in the field.
b. Pumps shall be driven by the motors to be supplied with the pumping units.
c. Pumps and motors shall be properly identified so the matched units are installed as tested.

C. Motor Tests:

1. Each motor shall have a non-witnessed factory test conducted at the motor manufactures facility prior to shipment.
2. The actual values of the complete test shall be measured and run in accordance to the applicable provisions for Standard Routine Motor Test Code MG20.46 and the American Test Code.
3. All tests shall be made at the full design voltage unless specified otherwise.
4. All tests will be made in accordance with IEEE #112B and reported on Form G of that manual. Complete test shall include, but not be limited to, the following for each motor rating:

a. No load running current.
b. High potential test.
c. Winding resistance test.
d. Full load heat run.
e. Percent slip.
f. Current balance check.
g. Pull out, starting and breakdown torque.
h. LR current.
i. Efficiency at full, 3/4 and 1/2 load.
j. Power factor at full, 3/4 and 1/2 load.
k. Bearing inspection and temperature recordings.
l. Vibration test.

3.2 INSTALLATION

A. All pumps shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings.

B. Field test shall not be conducted until such time that the entire installation is complete and ready for testing.

C. A certificate from each equipment manufacturer stating that the installation of his equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit shall be submitted.

D. Base Installation

E. The Contractor shall ensure that the pump discharge and suction flange are not

supporting the weight of the piping or valves. The motor and pump may be removed for grouting purposes. After grouting is complete and prior to start-up, the motor and pump shall be aligned with a laser device. Prior to installing the coupling, the motor rotation must be verified.

END OF SECTION

SECTION 44 40 00

COMMON REQUIREMENTS FOR POLLUTION CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Common requirements for all process equipment specified in Divisions 44.

B. Related Specifications

1. Division 01 for general requirements applicable to the work of this Division.

C. Related Drawings

1. Responsibility Schedule defining the responsibilities for furnishing, installing, wiring, and other requirements relating to process equipment specified in this Division.
2. Civil Drawings for installation and piping connections of equipment required in this Division.
3. Electrical Drawings for locations and installation of Control Panels, Electrical Equipment and Instruments furnished loose, for field installation.

D. Manufacturer’s Responsibilities

1. Design and performance of the systems and of the individual components included in the systems.

    a. Design of process and selection of components to meet the performance criteria outlined in each Section of this Division.
    b. Structural Design
    c. Electrical Design
    d. Ventilation and Cooling of enclosed components

2. Wiring, electrical components, and instruments to be incorporated into finished assemblies and packaged systems.
3. Control Panels, Electrical components, and instruments to be furnished loose for field installation.
4. Prepare Submittals as specified in this Section and as specified in the individual Sections of this division.
5. Quality Assurance: Factory testing, inspections and certifications as specified.
6. Furnish all components unless indicated to be furnished by others.
7. Provide on-site representation and services as specified.
8. Each manufacturer shall guarantee the performance of the system in accordance with the performance requirements specified.
9. Provide special tools required for operation and maintenance.
10. Provide spare parts specified in each Section.
11. Provide lubricants and other maintenance materials required for one year of operation.

E. General Contractor's Responsibilities

1. Administration of Submittals.
2. Coordination of construction activities, conferences, and manufacturer's representation on-site.
3. Provide copies of approved submittals to the licensed electrician performing the electrical construction scope.
4. Install control panels, electrical components, and instruments furnished loose or not incorporated in finished assemblies and packaged systems.
5. Provide piping, valves, supports, anchors, hardware, and incidental items not furnished by the equipment manufacturer, necessary to complete the installation.
6. Verify all details of installation, including dimensions, locations and sizes of anchor bolts, supports, and weights.
7. Verify locations of junction boxes on the Electrical Drawings and verify lengths of submersible and other special cables to be furnished with equipment.
8. Verify lengths and sizes of lifting cables and chains, and compatibility with lifting and hoisting equipment.
9. Make field connections of process piping to the equipment.
10. Provide water and materials for testing.
11. Perform testing of installed work.
12. Certify that each piece of equipment has been installed in accordance with the manufacturer's instructions and is ready to start up.

1.3 PERFORMANCE REQUIREMENTS

A. Design and build equipment to meet the performance requirements provided in each Section.

1. Provide systems and equipment complete and operable with all components and accessories required to provide the required function, serviceability, and durability.
2. Each Manufacturer is responsible for selecting electric motors of the proper horsepower for each component and including the cost in the Bid Price. Motor horsepower stated in each Section was used as the basis of design for work by the Electrical Contractor and may be superseded by the Manufacturer's actual requirements. All changes shall be noted by the respective manufacturer when submitting Product Data as specified in Section 01 33 00.

B. Environmental Conditions

1. Provide explosion proof equipment where specified in the individual specification Sections or indicated on the Drawings.

C. Performance Guarantee

1. The Manufacturer shall guarantee the system to meet the performance requirements for a period of one year.

1.4 SUBMITTALS

A. In addition to the specific submittals required in each Section of this Division, submit the following:

1. Fully dimensioned drawings, including anchor bolt locations, lifting points, weights, special lifting devices, and clearances required for service and maintenance.
2. Locations, types, and sizes of piping connections.
3. Part lists and materials of components.
4. Spare parts, and special tools required for installation and maintenance.
5. Rotational speed for rotating equipment.
6. Electrical cables furnished with the equipment.
7. Drive belts, bearings, shafts, hoses, valves, and other accessories.
8. Instruments mounted on or in equipment.
9. Instruments furnished loose.
10. Control Panel materials of construction and enclosure type.
11. Product Information for components in control panels
12. Single Line Diagram and Control system schematics.
13. Motor Data, including voltage, speed, rated horsepower, motor temperature rating, full load rotational speed, full load current, locked rotor current, and moisture and temperature sensors.
14. Wiring and terminal diagrams for use by the Electrical Contractor to make field wiring connections. Coordinate with labels and tags indicated on the Electrical and Process Control Integration Drawings.
15. Manufacturer's installation instructions.
16. Manufacturer's Field Reports for Testing and Startup

17. Training Materials and Training Logs

1.5 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Manufacturer shall have the experience and history of successful installations as specified.

B. Installer Qualifications: Provide qualified Installers as specified in Section 017300. Manufacturer's Installer, where required, shall be authorized representative who is trained and approved for installation of units required for this Project.

C. Comply with applicable industry standards and regulations of authorities having jurisdiction, and the standards listed in the respective Sections.

1.6 PROJECT CONDITIONS

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

1. Notify Engineer and Owner no fewer than five days in advance of proposed interruption of operations or service and obtain written permission.
2. Verify permission with Engineer and Owner immediately before interrupting operations or service.

1.7 COORDINATION

A. Coordinate size and location of concrete bases, anchors, and piping connections.

B. Coordinate clearances and ensure completion and readiness of other work required for installation of the products specified in this Section.

C. Arrange for the manufacturer’s on-site representation and services.

1.8 WARRANTY

A. Provide Special Warranties specified for each system or equipment item that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.

b. Faulty operation of motors, equipment, controls, or accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Test and inspect components. Include test recordings that substantiate correct performance.

B. Test accessories and controls through complete operating cycles. Include test recordings that substantiate correct performance.

2.2 MATERIAL SELECTION

A. Corrosion Resistance

1. Fabricated items, supports, anchors, and hardware, any of which will be submerged, subject to splashing or spray, or are inaccessible for inspection and painting, shall be fabricated of corrosion resistant materials such as stainless steel, fiberglass, plastic, or aluminum unless indicated otherwise. No painted carbon steel components may be furnished for this use.
2. Mechanical components such as gear reducers, pumps, motors, valves, and actuators may be provided of standard materials with manufacturer’s standard finishes for the use intended.

B. Stainless Steel Products

1. All Stainless Steel Products to be welded shall have extra low carbon content (0.03% max). Provide 304L or 316L where type 304 or 316 are specified, respectively.

C. Galvanic Corrosion Protection

1. Provide dielectric couplings, washers, sleeves, paint, or other approved protection at connection points of dissimilar metals.
2. Provide approved coatings on aluminum products in contact with concrete.

2.3 WELDING

A. All welding shall be completed at the manufacturer’s fabrication facilities. Field welding is not permitted.

B. All welding of Stainless Steel shall be by the shielded arc, inert gas, MIG or TIG method with gas shielding on both sides. Add filler material to provide a cross section equal to, or greater than the parent material. Butt Welds shall have full penetration. All exposed surfaces shall be wire brushed with a stainless steel brush to remove weld splatter.

C. All pipe welding shall provide continuous welds. Slip-on flanges and face rings shall be welded on both sides.

2.4 ANCHORS

A. Unless specified otherwise, the Contractor shall furnish and install anchor bolts into concrete.

B. Materials

1. Provide minimum 304 stainless steel anchors for stainless steel, painted steel, cast iron, aluminum, and non-metallic items and assemblies.
2. Provide hot dip galvanized steel anchors for galvanized steel items and assemblies.

C. Type: Provide drilled-in epoxy anchor bolts, size and length as recommended by the equipment manufacturer. Provide additional length as required to accommodate leveling and placement of grout pads under equipment bases.

2.5 ENVIRONMENTAL PROTECTION

A. General Requirement: Equipment and panels shall be rated and designed for ambient conditions at the location of installation.

1. Equipment located outdoors shall be protected from rain, condensation, overheating, and freezing. Provide suitable covers, guards, sealing materials, NEMA Ratings, anti-condensation heaters, heat tracing, insulation, ventilation, and other protective measures as specified or as required.
2. Equipment exposed to potentially corrosive atmospheres shall be manufactured with corrosion resistant components, sealing materials, and other protective measures as required.
3. Equipment located in humid conditions shall be protected from condensation. Provide anti-condensation heaters and other protective measures as required.
4. Equipment located in proposed structures shall be designed for adequate cooling with a temperature of 104° inside the structure.

B. Specific Requirements: The locations of the equipment and panels are shown on the Drawings. Required NEMA ratings are specified in the individual Sections in this Division.

2.6 MACHINE GUARDING

A. Provide Guards for rotating and moving components, gears and pulleys, and at other danger zones, and provide cut-off devices in accordance with OSHA standards.

2.7 INSTRUMENTS AND CONTROLS

A. The individual specifications in this Division indicate instruments that are required to be furnished by the equipment manufacturer.

B. The individual specifications in this Division indicate control panels and other controls that are required to be furnished by the equipment manufacturer. Control Panels shall comply with the following:

1. Provide Explosion-proof panels where required.
2. Freestanding or Wall-Mounted Panels as specified in the individual Section.
3. Provide engraved plastic tags for each device on the panel face. Control Panel label shall include Tag Number and Device Name.
4. Provide Indicator Lights conforming to the following Standardization

    a. Red – Alarm or Fault resulting in shutdown of equipment
    b. Amber – Notable condition not resulting in shutdown of equipment.
    c. Green – Running
    d. White – Control Power is On

5. Panel Dimensions: Panels to be installed in areas of limited space shall not exceed the width and depth dimensions specified in the individual Sections of this Division.
6. Design controls to automatically recover and resume normal operation after a power outage without intervention by the operator.

    a. A delay of several minutes may occur before the emergency generator reaches stable operation and loads are transferred to the generator. An interruption will also occur at the end of the power outage, as the power supply is transferred back to the utility power supply.
    b. PLC-based controls shall include uninterruptible power supplies capable of powering all controls for 60 minutes.
    c. Relay-based controls shall be designed to clear and reset their status to facilitate restarting, regardless of the sequences in progress at the time of the interruption.

7. All wires entering or leaving control panels shall attach to terminals.

8. All indicator lights shall be LED type. No incandescent bulbs are permitted.
9. All control panels shall include a 120-volt receptacle.
10. All control panels shall include a Transient Voltage Surge Suppressor, listed by the UL as TVSS.

2.8 ELECTRIC MOTORS

A. Referenced Standards

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. NEMA MG 1 - Motors and Generators.
3. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. Motor Characteristics

1. Provide motors as specified in the individual Specification Sections

   a. Single Phase or Three phase as specified.
   b. Inverter Duty as specified.
   c. Voltage characteristics as specified.
   d. Explosion proof as specified.

2. Bearings: Rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum, V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
3. Design for continuous operation in 40-degree C environment, with temperature rise according to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. Enclosure: Meet conditions of installation unless specific enclosure is specified or indicated

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect equipment for damage upon arrival at the site. Verify items listed in the documentation are included in the shipment and report any discrepancies to the manufacturer.

B. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

C. Examine dimensions of piping systems to verify actual locations of piping connections before equipment installation.

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

3.2 INSTALLATION

A. Install components where indicated, according to specific equipment and piping arrangement indicated.

B. Follow the manufacturer’s installation drawings and instructions.

C. Verify direction of flow in piping and proper orientation of valves.

D. Install equipment level, plumb, and aligned properly.

E. Check data plates for compatibility to service voltage.

F. Verify that fuses and circuit breakers conform to project design documents. Manually operate circuit breakers and switches to ensure proper operation. Open all circuit breakers and disconnects before connecting power. Verify line voltage, phase sequence, and ground before startup.

G. Check tightness of all fasteners.

H. Verify proper installation of supports and anchors for equipment and piping.

I. Grout bases as recommended by the equipment manufacturer.

J. Lubricate all bearings.

K. Verify proper rotation of motors and equipment.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping.

B. Provide flanges, couplings, expansion joints, or other devices to permit future removal of equipment, and to control transmission of vibration or movement to connecting piping.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.4 FINISHES

A. Provide equipment components with the Manufacturer’s standard coatings or finishes unless specified otherwise in the specific Section.

B. Repair damage to finishes in accordance with the Manufacturer’s instructions.

C. Where factory painting is not provided, or prime coats only are provided, perform field Painting in accordance with the manufacturer’s recommendations and the applicable Painting Specification.

D. Provide specified finishes on aluminum, stainless steel, and fiberglass. Painting is not required on these materials unless specified otherwise.

3.5 IDENTIFICATION

A. Install identifying labels permanently attached to equipment.

B. Install operating instruction signs permanently attached to equipment or on wall near equipment.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing to the Engineer.

1. Provide the number of visits and the number of hours of on-site representation and services as specified in each Section

B. Tests and Inspections:

1. After installing components and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for tests.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Observe operation of equipment and note any undue noise, vibration, or other operational problems. Submit a written Test Report to the Engineer.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Adjust sensor, accessory, and control settings, and safety and alarm devices.
3. Submit a written report documenting Start-Up Results.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the system. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 46 05 53

IDENTIFICATION FOR WATER AND WASTEWATER EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.

B. General Requirements:

1. Provide Identification for Equipment Identified on the Drawings with a Tag Number.
2. Equipment Identification shall include the Name and Tag number, such as “Transfer Pump P-1” as noted or scheduled on the Drawings.
3. Valve Identification shall include the Tag Number, such as “PV-3”
4. Engraved Plastic Nameplates may be attached to equipment with covers, enclosures, bases, or other suitable flat surfaces. If a suitable location does not exist on the equipment, nameplates may be attached to the wall adjacent to the equipment or other location acceptable to the Engineer.
5. Valves, gates, and other equipment with hand wheel operators shall have Engraved Plastic Tags attached to the hand wheels.
6. Small valves may have Engraved Plastic Tags attached to the adjacent piping.
7. Identification is not required for buried valves.
8. Access doors, hand operated stop gates, stop logs, and other fabricated items may have the Identification painted-on with the use of stencils.
9. No adhesive labels are permitted for use in Identification.

C. Related Requirements:

1. Section 46.

2. Process Drawings.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Nameplates.
2. Tags.
3. Stencils.

B. Shop Drawings:

1. Submit list of wording, symbols, letter size, and color coding for equipment identification and schedule, including equipment number, location, function, and manufacturer's name and model number.

PART 2 - PRODUCTS

2.1 TANK NAMEPLATES

A. Mark each tank with stainless-steel name plate not less than 4 inches by 6 inches in size and attached to outside of tank wall.

B. Print following information on nameplates:

1. Name of manufacturer.
2. Capacity in gallons.
3. Manufacturer serial number.
4. Year built.
5. Maximum specific gravity.
6. Design pressure and temperature.
7. Resin.

2.2 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved black letters on light, contrasting background color.

B. Minimum Size and Configuration: Rectangular, 1-1/2” height and length as required. Text size; 1-inch. Drilled at each end to accommodate attachment hardware.

2.3 TAGS

A. Description: Laminated three-layer plastic with engraved black letters on light, contrasting background color.

B. Minimum Tag Size and Configuration: Rectangular, 1-1/2” height and length as required. Text size; 1-inch. Drilled at one end to accommodate attachment hardware.

2.4 STENCILS

A. Description: Interlocking, self-aligning, brass or plastic characters.

B. Size: 2” characters.

C. Stencil Paint: High performance spray enamel for metal. Bright Red Color.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION OF NAMEPLATES

A. Install identifying devices after completion of coverings and painting.

B. Identify equipment with plastic nameplates.

C. Identify control panels and major control components outside panels with plastic nameplates.

D. Install plastic nameplates with corrosion-resistant mechanical fasteners.

3.3 INSTALLATION OF TAGS

A. Install identifying devices after completion of coverings and painting.

B. Identify inline pumps and other small devices with tags.

C. Install tags using corrosion-resistant chain.

3.4 INSTALLATION OF STENCILS

A. Install identifying devices after completion of coverings and painting.

B. Identify equipment with stencils.

C. With use of Stencils, prevent overspray with suitable masking or covers.

END OF SECTION

SECTION 46 07 53

PACKAGED WASTEWATER TREATMENT EQUIPMENT

1.1 SUMMARY

A. Section Includes: The furnishing of a complete packaged industrial waste treatment system, consisting of multiple, separate process components designed to function together as an integrated treatment system, capable of treating industrial waste containing metals and cyanide by means of chemical precipitation.

B. All major components shall be supplied by a single-source packaged system supplier to ensure compatibility, coordinated operation, and compliance with performance requirements.

C. The major system components include, but not limited to:

1. Equalization Tanks.
2. Transfer Pumps.
3. Cyanide Batch Treatment System.
4. Continuous Precipitation System
5. Powdered Chemical Make-up System.
6. Post-Equalization Tank.
7. Bag Filtration System.
8. Neutralization System.
9. Plate and Frame Filter Press.
10. Flow metering.
11. Main Control Panel.
12. All related chemical feed and mixing equipment.

1.2 BASIS OF DESIGN

A. Basis of Design Supplier: Evoqua Water Technologies (Evoqua).

B. The design, performance, and layout are based on Evoqua’s packaged industrial waste treatment equipment package.

C. Other suppliers may be considered only if they furnish all listed components as a coordinated package, meeting performance requirements.

D. The supplier shall guarantee the performance based on the performance and design criteria presented in this Section.

1.3 SUBSTITUTIONS

A. All major components listed in 1.1C shall be furnished by the same single-source packaged system supplier.

B. Substitution of individual components from other suppliers or manufacturers is not permitted.

C. Alternate suppliers may be considered only if they provide the complete system, including all listed components, with full responsibility for compatibility, integration, and performance.

D. Approval of alternatives must be obtained in writing from the Engineer prior to bid.

E. Changes in structural, electrical, mechanical, and plumbing requirements for any approved alternative supplier shall be the responsibility of the Bidder. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected contractors shall be the responsibility of the Bidder and not the Owner.

1.4 DEFINITIONS

A. Suspended Solids (SS): Small solid particles that remain in suspension in water.

B. Total Suspended Solids (TSS): All particles suspended in water that will not pass through a filter.

1.5 COORDINATION

A. Section 01 30 00 – Administrative Requirements: Requirements for coordination.

B. Coordinate installation and startup of Work of this section with Engineer and Owner.

1.6 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures: Requirements for Submittals.

B. Product Data: Submit supplier’s product data for system materials and component equipment.

C. Shop Drawings:

1. Indicate system materials and component equipment, including process flow diagrams, equipment layout, piping connections, and detailed wiring and control diagrams.
2. Indicate complete plan, elevation and sectional drawings showing critical dimensions.
3. Indicate complete information concerning fabrication, installation, anchoring, fasteners, and other details.
4. Signed and sealed by the qualified professional engineer responsible for their preparation.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1. Certify that installation is completed according to manufacturer's instructions and that packaged industrial waste treatment plant is ready for startup, testing, and operation.
2. Submit manufacturer's affidavit certifying tanks have been designed to resist loading and attest to structural adequacy; calculations are not to be submitted.

E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for major components specified in Section 1.1C.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Indicate results of manufacturer's inspections and instructions issued.

I. Qualifications Statements: For manufacturer, installer, and licensed professional.

J. Submit Manufacturer's Approval: For installer.

1.7 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for closeout procedures.

B. Operation and Maintenance Data: Submit equipment operation and maintenance manuals.

1. Include periodic maintenance recommendations.
2. Submit list of equipment, accessories, and tools needed to maintain and calibrate equipment.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for maintenance manuals.

B. Spare Parts:

1. Furnish one set of manufacturer's recommended spare parts.

C. Tools: Furnish special wrenches and other devices required for Owner to maintain system components.

1.9 QUALITY ASSURANCE

A. Manufacturers Qualifications: Company specializing in manufacturing products specified in this Section with minimum ten (10) years' documented experience.

B. Installers Qualifications: Company specializing in performing Work of this Section with minimum Three (3) years' documented experience.

C. Licensed Professionals Qualifications: Professional engineer experienced in design of specified Work and licensed in State of Oklahoma.

D. Welders Qualifications: AWS-certified within previous 12 months.

1.10 WARRANTY

A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for packaged wastewater treatment equipment.

PART 2 - PRODUCTS

2.1 PACKAGED TREATMENT SYSTEM DESCRIPTION

A. Manufacturers:

1. Basis of Design: Evoqua Water Technologies.
2. Substitutions: Refer Section 1.3.

B. Description:

1. Packaged industrial waste treatment plant with tanks, equipment, instruments, and accessories as described below:

a. Equalization Tanks.
b. Transfer Pumps.
c. Packaged Cyanide Batch Treatment System.
d. Packaged Continuous Precipitation System
e. Powdered Chemical Make-up System
f. Bag Filtration System.
g. Neutralization System.
h. Plate and Frame Filter Press.
i. Flow metering.
j. Main control panel.

2. The equipment for the packages treatment system shall be as described herein and as shown per general arrangement drawings.

3. A process control system shall be provided to monitor and control pH and ORP in the treatment system based on process objectives.
4. Basis of design supplier shall supply skidded equipment and loose ship containers to be field installed by the Contractor. The Contractor shall provide supports, anchors, piping, pipe connections, hardware, and other items specified, shown on the Drawings, or as required to produce a complete and operable system.

C. Performance and Design Criteria:

1. Maximum Influent Criteria:

a. Hydraulic Design Flow Rate: 30 gpm.
b. pH: 2-12
c. TSS (mg/l): 300 mg/l
d. Cadmium (T): 10 mg/l
e. Chromium (T): 50 mg/l
f. Copper (T): 50 mg/l
g. Lead (T): 5 mg/l
h. Nickel (T): 50 mg/l
i. Silver (T): 5 mg/l
j. Zinc (T): 50 mg/l
k. Cyanide (T): 50 mg/l

2. Performance Criteria: Produce effluent quality from treatment plant neutralization system with following maximum limits:

a. Cadmium (T): 0.05 mg/l
b. Chromium (T): 1.50 mg/l
c. Copper (T): 1.14 mg/l
d. Lead (T): 0.57 mg/l
e. Nickel (T): 3.98 mg/l
f. Silver (T): 0.43 mg/l
g. Zinc (T): 2.17 mg/l
h. Cyanide (T): 1.20 mg/l
i. Total Organics: 2.13 mg/l
j. Cyanide (Amendable to Chlorination): 0.17 mg/l

3. For all equipment, motors and electrical components shall be installed with a minimum elevation of 6.00 inches above FFE, to ensure protection from contained fluids in the event of a tank rupture.

2.2 EQUALIZATION TANKS

A. Description:

1. Four (4) 5,000-gallon capacity collection/equalization tanks.

B. Configuration:

1. Capacity: 5,000-gallon, each.
2. Orientation: Vertical.
3. Cylindrical Walls.
4. Bottom: Flat, nonsloping.
5. Top: Dome top with manway.
6. Color: Natural translucent allowing observation of liquid level inside.

C. Components:

1. Nozzles

   a. Top-Mounted Accessway: one 16-inch ID flanged opening in top with cover.
   b. Sump-Type Drain: one 2-inch diameter flanged, capable of completely draining tank.
   c. Vent: 6-inch diameter flanged opening in top.
   d. Top Fill: 4-inch diameter flanged connection in top.
   e. Pump Suction: 2-inch diameter flanged connection.
   f. Nozzles shall be installed in the locations as shown on the Drawings.

2. Level Controls

   a. High level, low level float switches.
   b. Liquid level visible through wall of tank.

3. Tank Name Plate

   a. Mark each tank with name plate in accordance with Section 46 05 53.
   b. Anchors:

      1) Furnish each storage tank with FRP hold-down lugs with stainless-steel anchor bolts.
      2) Furnish minimum of eight lugs for each tank.

D. Materials:

1. Fiberglass reinforced plastic (FRP)
2. Use same resin throughout construction of each tank
3. Piping: Schedule 80 PVC or CPVC.

2.3 TRANSFER PUMP SYSTEM

A. Basis of Design: Duplex Transfer Pump Skid Model No. PS-30D by Evoqua.

B. Description:

1. Pre-piped and pre-wired, duplex arrangement Transfer Pump System, designed to be used with collection tanks. Pumps, valves, flow indicator, flow control valve and control panel mounted on a corrosion-resistant painted steel skid.

C. Components:

1. Pumps:

a. Skid-mounted duplex arrangement, two (2) 1.5 HP horizontal centrifugal pumps.
b. Capacity: Each pump shall be rated for 30 gpm at 50 ft TDH.
c. Motor: 1.5 HP, 460 Volts, 3-phase, 60 Hz, TEFC.
d. Pump Control: Four float switches - pumps off, lead pump on, both pumps on, high water alarm.

2. Piping Connections:

a. Suction Connection: 2-inch Sch. 80 PVC.
b. Discharge Connection: 2-inch Sch. 80 PVC.

3. Valves:

a. Suction: Two (2), PVC Isolation Ball Valve.
b. Discharge: Two (2), PVC Isolation Ball Type.
c. Discharge Check Valve: Two (2) PVC Check Valve.
d. Discharge Throttle Valve: Diaphragm Type.

4. Instrumentation:

a. Pressure: One (1) discharge pressure gauge

1) See Section 40 91 00 – Primary process Measurement Devices.

b. Flowmeter: Rotometer.
c. Level Control: Float.

D. Materials:

1. Pump: Noryl.
2. Skid: Corrosion Resistant painted steel.
3. Electrical: NEMA-4X enclosures, UL-listed components.
4. Piping: Schedule 80 PVC.

2.4 BATCH TREATMENT SYSTEM

A. Basis of design: Batch Treatment System BT-500 by Evoqua.

B. Description: Pre-piped and pre-wired packaged Batch Treatment System to perform semi-automatic batch chemical precipitation operation and pH adjustment. The system includes a batch tank, two chemical feed pumps, a decant port, a pH indicator/controller, a mixer, a high level alarm and a local electrical control panel.

C. Components:

1. Tank:

    a. Orientation: Vertical, Cone bottom Tank.
    b. Dimensions: 54-inch diameter, 96-inch height
    c. Capacity: 500 gallons
    d. Cover: ½" Poly half-cover

2. Piping Connections and Valves:

    a. Drain: 2-inch diameter; flanged with 2-inch True Union Ball Valve, capable of completely draining dank.
    b. Outlet: 2-inch diameter; flanged with 2-inch True Union Ball Valve.

3. Instrumentation:

    a. Mixer:

        1) One (1) mechanical, gear reduced mixer with 0.33HP TEFC motor

    b. pH:

        1) One (1) pH monitor/transmitter
        2) See Section 409100 – Primary process Measurement Devices.

    c. ORP

        1) One (1) ORP monitor/transmitter
        2) See Section 409100 – Primary process Measurement Devices.

    d. Chemical Control:

        1) Three (3) PVC Chemical Metering Pumps for caustic, acid, and bleach.
        2) See Section 409100 – Primary process Measurement Devices.

4. Controls:

    a. NEMA-4X local control panel with pH controller, high-level alarm, and cycle logic.

5. Access platform:

    a. Integral platform
    b. 7-Step Rolling Warehouse Ladder

D. Materials:

1. Tank: Fiberglass Reinforced Plastic (FRP)
2. Access Platform: Epoxy Coated Carbon Steel
3. Mixer: 316 Stainless Steel

E. Utility Requirements:

1. Power: 480 V, 3 Phase, 60-Hertz.

2.5 CONTINUOUS PRECIPITATION SYSTEM

A. Basis of Design: Continuous Precipitation System Model No. CPS-30-ST-L-T-S-DP-X-1B-2B by Evoqua.

B. Description:

1. One (1) modular, epoxy painted, carbon steel constructed multi-chamber unit rated for 30 gpm for continuous treatment of industrial wastewater. The system includes a multi-chamber tank that contains a chemical reaction section, flocculation section, clarifier, effluent clearwell chamber, and sludge age section. The system is equipped with the necessary mixers, instrumentation, valves and PLC controls. It is designed as a full operating system module.

C. Design Parameters:

1. Design Flow Rate: 30 gpm.

D. Components:

1. The pre-packaged unit contains the following treatment equipment:
2. First Stage Reaction Chamber

a. Capacity: 320 gallon.
b. Mixer:

1) One (1) Single-speed, gear drive agitator, 0.25 HP, 1725 RPM driver, 316 SS wetted parts (Lightnin or equal)

c. One (1) pH electrode

a) See Section 40 91 00 – Primary process Measurement Devices.

d. One (1) ORP electrode

1) See Section 40 91 00 – Primary process Measurement Devices.

3. Second Stage Reaction Chamber

a. Capacity: 320 gallon.

1) One (1) Single-speed, gear drive agitator, 0.25 HP, 1725 RPM driver, 316 SS wetted parts (Lightnin or equal)

b. One (1) pH electrode

1) See Section 40 91 00 – Primary process Measurement Devices.

4. Flocculation Chamber

    a. Capacity: 150 gallon.
    b. Mixer:

        1) One (1) Polypropylene and stainless-steel constructed paddlewheel type agitator, 14 RPM.
        2) Low speed gear type agitator drive motor, 0.17 HP.

5. Clarifier Chamber

    a. Capacity: 1,360 gallon.
    b. Settling modules with chevron shaped tube packing.
    c. Three (3) automatic, air actuated sludge withdrawal valves.

6. Sludge Age Chamber Feed Pump

    a. One (1) air operated double diaphragm pump (ARO or equal).
    b. Cast iron construction.

7. Effluent Clearwell:

    a. 95-gallon capacity.
    b. Effluent Connection: 3-inch Sch 80 CPVC piping connection

8. Sludge Age Chambers

    a. Two (2) 400-gallon capacity tanks.
    b. Two (2) single point, float type, PVC and polypropylene constructed level switches.
    c. Pumps:

        1) One (1) Decant air operated diaphragm pump (ARO PD10P-YPS-PAA) or equal)
        2) One (1) Solid recycling air operated diaphragm pump (ARO PD10A-ACS-AAA or equal)
        3) One (1) Sludge thickener feed air operated diaphragm pump (ARO PD05P-ARS-PAA-BPD05P or equal).

9. Chemical Control:

    a. Four (4) Chemical Metering Pumps

        1) See Section 40 91 00 – Primary process Measurement Devices.

10. Operator Access Platforms:

    a. Two (2) platforms with handrail and toeplate.
    b. Carbon Steel construction.
    c. Access ladders.

E. Materials:

1. Tank: Carbon Steel

2.6 POWDERED CHEMICAL MAKE-UP SYSTEM

A. Basis of Design:

1. Powdered Chemical System Model No. PCP-50 by Evoqua

B. Description:

1. Fully-assembled Powdered Chemical Make-Up System for make-up of fully mixed polymer solution from powdered polymer and water. The system includes a tank with one mixer and one chemical metering pump mounted to the lid, and one low level float. The system is designed to feed the CPS flocculation chamber with the mixer polymer solution for improved flocculation.

C. System Components:

1. Tank: One 50-gallon capacity, vertical cylindrical tank
2. Mixer: One heavy-duty mixer (Brawn or equal)
3. Chemical Control: One chemical metering pump (LMI, Grunfos or equal)
4. Pump Control: Low level float switch

D. Materials:

1. Tank: HDPE construction
2. Mixer: 316SS Wetted Parts

2.7 POST-EQUALIZATION TANK

A. Basis of Design:

1. HDPE Equalization Storage Tank Model No. EQ-1000-HDPE by Evoqua

B. Description: One (1) 1,000-gallon capacity collection/equalization tank sized to collect the clarified water from the CPS effluent clearwell.

C. System Components:

1. Tank:

a. Capacity: 1,000-gallon capacity
b. Orientation: Vertical.
c. Cylindrical walls.
d. Bottom: Flat, nonsloping.
e. Top: Dome top with manway and vent.
f. Color: Natural translucent allowing observation of liquid level inside.

g. Mark each tank with name plate in accordance with Section 460553.

2. Level Controls:

a. High level, low level float switches.
b. Liquid level visible through wall of tank.

3. Nozzles

a. Top Mounted Accessway: one 16-inch ID flanged opening in top with cover.
b. Sump-type Drain: 2-inch diameter; flanged with 2-inch True Union Ball Valve, capable of completely draining dank.
c. Pump Suction: 2-inch diameter; flanged with 2-inch True Union Ball Valve.
d. Top Fill: 2-inch diameter flanged connection in top.
e. Nozzles shall be installed in the locations as shown on the Drawings.

D. Materials:

1. Tank: HDPE or FRP
2. Piping: Schedule 80 PVC or CPVC bulkhead connections.

2.8 BAG FILTRATION SYSTEM

A. Basis of Design:

1. Bag Filtration System Model No. Bag 100-C-1 by Evoqua.

B. Description: Bag Filtration System consists of two bag filter housings plumbed in parallel on a skid to perform pressure filtration of total suspended solids.

C. Design Parameters:

1. Configuration: Duplex Service / Standby or parallel flow
2. Application: Pressure filtration of Total Suspended Solids
3. Filters used: 7” x 16”: Size 01 standard bag filters
4. Feed Flow: 50 gpm duplex, 100 gpm parallel flow

D. System Components:

1. Bag Filter Housing:

a. Two (2) Bag Filter Housings.
b. 7” diameter by 16” Height.
c. Holds one (1) size #1 bag filter each.

2. Bag Filter

a. Hayward Industries Inc., or equal.
b. Size #1, (7” diameter x 16” long) singed finish with stainless steel ring.

c. Nominal Rating: 25 microns.

3. Piping Connections:

a. Piped in 3” Sch. 80 CPVC piping.
b. Inlet Connection: 3” Flange.
c. Outlet Connection: 3” Flange.
d. Drain Connection: ½” PVC/CPVC socket.

4. Manual Valves:

a. Housing inlet and outlet:

1) Minimum two per each housing: inlet and outlet.
2) True union ball valve.

b. Sample tap:

1) Minimum two per unit: Influent sample and effluent sample.
2) Design and Placement: According to Manufacturer’s standard.
3) Sample Valve: ¼” PVC/CPVC Labcock valve.

c. Drain Valve: ½” PVC/CPVC ball valve.

5. Instrumentation:

a. One (1) differential pressure switch

1) Ashcroft, or equal
2) 316 SS connections, ¼” NPT.

b. Four (4) pressure gauges

1) Pressure gauge for each inlet and outlet.
2) 316 SS, 63mm dial, glycerine filled, ¼” NPT.

E. Materials:

1. Frame: Welded structural carbon steel, NiKlad 3000 coated.
2. Bag Fiter Housings: PVC/CPVC
3. Filter: Polyester Felt.
4. Piping: PVC/CPVC

2.9 NEUTRALIZATION SYSTEM

A. Basis of Design:

1. Neutralization System Model No. NSP-500 by Evoqua.

B. Description: Pre-piped and Pre-wired skid-mounted Neutralization system perform final pH adjustment to the conditions required for discharge. The system includes a reaction

tank equipped with one mixer, one chemical pump and one pH meter. The skid frame supports the mixer, probes and chemical pump. The electrical control box, piping manifolds, conduit and wiring harnesses are also attached to this frame. The addition of the neutralizing agents takes place automatically by a pH controller. The neutralized effluent leaves the system by gravity. A chart recorder shall be provided to record the pH.

C. Design parameters:

1. Recommended through-put: 40 gpm.

D. System Components:

1. Tank:

a. Orientation: Vertical, Cylindrical, Flat bottom.
b. Dimensions: 48-inch diameter, 72-inch height
c. Capacity: 500 gallons
d. Open top with half-cover

2. Piping Connections:

a. Inlet: 3” Sch, 80 flanged.
b. Outlet: 4” Sch. 80 flanged
c. Drain: 2” Sch. 80 flanged

3. Manual Valves:

a. Drain Valve: 2” True Union ball valve.

4. Instrumentation:

a. Mixer:

1) One (1) mechanical, gear reduced mixer (Lightning or equal)
2) 0.33HP, 1725 RPM TEFC motor

b. pH:

1) One (1) pH monitor/transmitter

a) See Section 40 91 00 – Primary process Measurement Devices.

5. Controls

a. Chemical Control:

1) One (1) Chemical Metering Pump
a) See Section 40 91 00 – Primary process Measurement Devices.

E. Materials:

1. Tank: FRP or HDPE.
2. Skid: Near white metal sandplast + 2-3 mil primer – 3-5 mil finish.
3. Mixer: 316 SS wetted components.
4. Piping: Sch. 80 PVC.

2.10 PLATE AND FRAME FILTER PRESS

A. Basis of Design: J-Press Sidebar Filter Press Model No. 470G32-13-2MYLW by Evoqua

B. Description: sidebar filter press with manual plate shifting for producing high solids filter cake. Components include structural frame, sludge inlet assembly, plate compression system, cake discharge assembly, plate shifting system, and plate wash mechanism.

C. Design Parameters:

1. Structural Frame: Sidebar.
2. Filter Cake Capacity: 2 CF.
3. Working Pressure Rating: 100 psi.
4. Closure Systems: manual.
5. Manifold: Air blow down.

D. System Components:

1. Automatic Pump Control System (APCS):

   a. APCS automatically controls the filling cycle, gradually increasing the feed pressure of the slurry feed pump.
   b. APCS includes hydraulic pressure safety device that shuts down feeding cycle if a loss of hydraulic pressure occurs.

2. Plates:

   a. Plate Size: 470mm
   b. Material: Polypropylene
   c. Type: Gasketed
   d. Feed: Center Feed.
   e. Return: Four corner return.

3. Filter Cloths:

   a. Synthetic fabric compatible with wastewater sludge.
   b. Easily removable for cleaning.

4. Plate Shifter

   a. Plate shifting Mechanism: Semi-automatic, operator driven.
   b. Cloth washing: automatic.

c. Cake wash with air blow down.
d. Cloth shaker.
e. Scraping device.

5. Manifold Piping

a. Schedule 80 PVC filtrate drainage piping

6. Material handling:

a. One (1) Sludge cake dumpster

E. Materials:

1. Structural Frame: A-16 Stainless Steel with Nickclad coating.
2. Sidebar covers: Stainless steel.
3. Plates: Polypropylene

2.11 MAGNETIC FLOW METER

A. Description: One (1) magnetic flow meter with chart recorder prior to discharge to sanitary sewer.

1. See Section 40 91 00 – Primary process Measurement Devices.

2.12 MAIN CONTROL PANEL

A. Description: The Main Control Panel consists of a Programmable Logic Controller (PLC) and Human Machine Interface (HMI) mounted in a NEMA 4X, non-metallic enclosure with adequate remote I/O and software to complete automated operation of the Waste Treatment system.

B. The control system shall contain all interlocks, alarm functions and control as required for operation of the treatment system. It shall be furnished by the treatment system manufacturer.

C. Components:

1. Control panel equipment shall be mounted in NEMA 4X non-metallic enclosure.
2. Engineered Process Control to coordinate operation of all Evoqua supplied equipment.
3. Allen Bradley CompactLogix PLC.
4. Allen Bradley Panel Human Machine Interface (HMI).
5. Digital and Analog I/O (Input/Output) modules, 1 lot.
6. 24 VDC power supply.

2.13 ANCHORS AND HARDWARE

A. All anchor bolts shall be 316 stainless steel and furnished by the Manufacturer and set with proper projection by the Contractor in accordance with approved, certified drawings furnished by the Manufacturer.

B. All hardware shall be 316 stainless steel.

2.14 FINISHES

A. Motors, Electrical Components, and Control Cabinets: Manufacturer's standard finish.

2.15 SOURCE QUALITY CONTROL

A. Owner Inspection: Make completed assembly available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least seven (7) days before inspection is allowed.

B. Owner Witnessing: Allow witnessing of factory inspections, and test at manufacturer's test facility. Notify Owner at least seven (7) days before inspections and tests are scheduled.

C. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

1. Specified shop tests are not required for Work performed by approved fabricator.

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 equipment and piping to verify actual locations of piping connections before installation of all major components identified in Section 1.1C.

C. Examine walls, floors, and roofs for suitable conditions where packaged wastewater treatment equipment will be installed.

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

3.2 INSTALLATION OF PACKAGED WASTEWATER TREATMENT EQUIPMENT

A. Erect wastewater treatment equipment on foundation according to Drawings and manufacturer's installation instructions.

B. Complete bolting to connect tanks and to mount equipment.

C. Install piping, and appurtenances as indicated on Drawings and according to manufacturer's instructions.

1. Install and connect piping, accessories, and power as required to ensure complete, operable system.

2. Connect to chemical day tanks and provide individual suction lines.

D. Install accessories and identification not factory mounted to complete installation.

3.3 FIELD QUALITY CONTROL

A. Welding:

1. If welds show evidence of leaking, empty tank and repair welds.
2. Remove defective welds by chipping or by arc or carbon gouging.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. Collection Tank Field Testing:

a. Hydrostatically test each FRP and HDPE tank by filling with water to the overflow pipe level.
b. Conduct test minimum 48 hours.
c. No leakage permitted.

2. Performance Testing of Treatment Plant:

a. After field adjustments are completed, test treatment unit under operating conditions continuously for three consecutive days to demonstrate unit compliance with design criteria, and permit discharge limitations.
b. Testing for influent and effluent metals and cyanide concentrations.
c. Take one sample of influent and effluent at 8:00 AM and 4:00 PM on each of three days for total of six influent and six effluent samples.
d. Conduct sampling under supervision of manufacturer's field representative and in presence of Architect/Engineer.
e. When wastewater treatment plant does not meet specified performance criteria within 60 days, modify system to meet performance criteria and rerun performance test; equipment modifications are subject to approval of Architect/Engineer.

f. When wastewater treatment unit fails to meet specified performance criteria within 60 days, remove unit from Project Site and replace with unit capable of meeting performance criteria, at no additional cost to Owner.

D. Prepare test and inspection reports.

3.4 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 – Quality Requirements: Requirements for manufacturer's field services

B. Furnish services of manufacturer's representative experienced in installation of products furnished under this specification for inspection, field testing, and instructing Owner's personnel in maintenance of equipment.
1. Provide a minimum of nine 8-hour days in three separate trips.
2. Representative shall be present during initial energizing of equipment.
3. Inspect and verify location of anchor bolts, leveling, alignment, and installation, control panel operation, and electrical connections.
4. Commission the process.
5. Provide training on the Operation and Maintenance of the equipment to the Owners personnel.
6. After the equipment has been placed in operation conduct a follow-up process check.

C. Provide one visit to the site consisting of two 8-hour days no less than one month prior to the end of the warranty period.

3.5 DEMONSTRATION

A. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

B. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

C. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION