

PROJECT MANUAL – Volume 2 of 2

Western Slope Food Bank of the Rockies

BID PACKAGE #4 – ABOVE GROUND

100% Construction Documents

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Architect's Project Number: 2108

OWNER:

Food Bank of the Rockies



ARCHITECT:

Chamberlin Architects, P.C.
437 Main Street
Grand Junction, CO 81501
(970) 242-6804

MECHANICAL ENGINEER:

Ralston Mechanical Consulting
356 Echo Canyon Court
Grand Junction, CO 81507
(970) 434-9819

STRUCTURAL ENGINEER:

Lindauer-Dunn, Inc.
802 Rood Avenue
Grand Junction, CO 81501
(970) 241-0900

ELECTRICAL ENGINEER:

Ron Slade, PE
745 Rood Avenue
Grand Junction, CO 81501
(970) 201-4302



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SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pipe, fittings, valves, and connections for sprinkler systems.
- B. Related Sections:
 - 1. Section 099000 - Painting and Coating: Execution requirements for piping painting specified by this section.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
 - 2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
 - 3. ASME B16.25 - Buttwelding Ends.
 - 4. ASME B16.3 - Malleable Iron Threaded Fittings.
 - 5. ASME B16.4 - Gray Iron Threaded Fittings.
 - 6. ASME B16.5 - Pipe Flanges and Flanged Fittings.
 - 7. ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
 - 8. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
- B. ASTM International:
 - 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
 - 3. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 4. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- C. American Welding Society:
 - 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 - 2. AWS D1.1 - Structural Welding Code - Steel.
- D. American Water Works Association:
 - 1. 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.
 - 2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

E. National Fire Protection Association:

1. NFPA 13 - Installation of Sprinkler Systems.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C. Product Data:
 1. Submit manufacturers catalogue information. Indicate valve data and ratings.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and tag numbering.
- C. Operation and Maintenance Data: Submit spare parts lists.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 13 and requirement of the authority having jurisdiction.
- B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Deliver and store valves in shipping containers, with labeling in place.
- C. Furnish cast iron and steel valves with temporary protective coating.
- D. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

1.11 EXTRA MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of valve stem packing for each size and type of valve installed.

PART 2 - PRODUCTS

2.1 VALVES

- A. Gate Valves:
 - 1. Up to and including 2 inches: Bronze body and trim, rising stem, hand wheel, solid wedge or disc, threaded ends.
 - 2. Over 2 inches: Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, hand wheel, OS&Y, solid bronze or cast iron wedge, flanged or grooved ends.
 - 3. Over 4 inches: Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, iron body indicator post assembly.
- B. Globe or Angle Valves:
 - 1. Up to and including 2 inches: Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity packable under pressure.
 - 2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.
- C. Ball Valves:

1. Up to and including 2 inches: Bronze or stainless steel two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle, threaded ends.
2. Over 2 inches: Manufacturers: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, flanged.

D. Butterfly Valves:

1. Bronze Body: Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, hand wheel and gear drive and integral indicating device, and built-in tamper proof switch rated 10 amp at 115 volt AC.
2. Cast or Ductile Iron Body: Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends. With extended neck, hand wheel and gear drive and integral indicating device, and internal or external tamper switch rated 10 amp at 115 volt AC.

E. Check Valves:

1. Up to and including 2 inches: Bronze body and swing disc, rubber seat, threaded ends.
2. Over 2 inches: Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends.
3. 4 inches and Over: Iron body, bronze disc with stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

F. Drain Valves:

1. Compression Stop: Bronze with hose thread nipple and cap.
2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

2.2 BURIED PIPING

- A. Refer to Civil Drawings and Specifications for fire suppression system underground pipe and fittings. Main piping into building shall match pipe installed beyond 5 ft. from foundation.

2.3 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A53/A53M, Grade B; ASTM A135/135M; ASTM A795/A795M; or ASME B36.10; Schedule 10 and 40 black.
1. Steel Fittings: ASME B16.9, wrought steel, butt welded; ASME B16.25, butt weld ends; ASTM A234/A234M, wrought carbon steel and alloy steel; ASME B16.5, steel flanges and fittings; ASME B16.11, forged steel socket welded and threaded.
 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings; ASME B16.4, threaded fittings.
 3. Malleable Iron Fittings: ASME B16.3, threaded fittings.
 4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.4 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 13.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Vertical Support: Steel riser clamp or angle ring.
- F. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION

- A. Install piping in accordance with NFPA 13 for sprinkler systems.
- B. Install Work in accordance with codes and standards adopted by authority having jurisdiction.
- C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- D. Install piping to conserve building space, to not interfere with use of space and other work.
- E. Group piping whenever practical at common elevations.

- F. Install pipe sleeve at piping penetrations through partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Pipe Hangers and Supports:
 - 1. Install in accordance with NFPA 13.
 - 2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Prime coat exposed steel hangers and supports. Refer to Section 099000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- I. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.
- J. Prepare pipe, fittings, supports, and accessories for finish painting.
- K. Do not penetrate building structural members unless indicated.
- L. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.
- M. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- N. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- O. Install ball or butterfly valves for shut-off or isolating service.
- P. Install drain valves at main shut-off valves, low points of piping and apparatus.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting, testing.
- B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

3.5 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Final cleaning.
- B. Clean entire system after other construction is complete.

END OF SECTION 210500

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SECTION 210516 - EXPANSION FITTINGS AND LOOPS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flexible pipe connectors.

B. Related Sections:

1. Section 210500 - Common Work Results for Fire Suppression: Product and installation requirements for piping used in fire protection systems.
2. Section 210548 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.9 - Building Services Piping.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

1.3 DESIGN REQUIREMENTS

- A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.

- B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints.

C. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per

- assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- D. Design Data: Indicate criteria and show calculations.
- E. Welders' Certificate: Include welders' certification of compliance with ASME Section IX or AWS D1.1.
- F. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- C. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Perform Work in accordance with NFPA 13 and requirement of the authority having jurisdiction.
- C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
- C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
 - 1. Flexicraft Industries.
 - 2. Metraflex Company (The).
 - 3. NIBCO INC.
 - 4. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - 5. Victaulic Company.
 - 6. Substitutions: Section 016000 - Product Requirements.
- B. Steel Piping:
 - 1. Inner Hose: Carbon Steel or stainless steel.
 - 2. Exterior Sleeve: Single braided stainless steel or bronze.
 - 3. Pressure Rating: 200 psig WOG and 250 degrees F.
 - 4. Joint: Flanged or Welded.
 - 5. Size: Use pipe-sized units.
 - 6. Maximum offset: 1 inch on each side of installed center line.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.9.
- B. Install flexible pipe connectors on pipes at locations of building expansion joints. Provide line size flexible connectors.

- C. Install flexible connectors at right angles to displacement. Anchor one end to building at one side of expansion joint and anchor other end to building at other side of expansion joint. Install in horizontal plane unless indicated otherwise.
- D. Rigidly anchor pipe to building structure. Erect piping so strain and weight is not on cast connections or apparatus.

END OF SECTION 210516

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wet-pipe sprinkler system.
2. System design, installation, and certification.

B. Related Requirements:

1. Section 210500 - Common Work Results for Fire Suppression: Pipe materials, fittings, check valves, and supervised valves.
2. Section 210513 - Common Motor Requirements for Fire-Suppression Equipment: Pump motors.
3. Section 211200 - Fire-Suppression Standpipes: Standpipe connection to wet-pipe sprinkler system.
4. Section 213000 - Fire Pumps: Connection of fire pump to wet-pipe sprinkler system.
5. Section 221100 - Facility Water Distribution: Domestic water supply and backflow preventers.
6. Section 260583 - Wiring Connections: Electrical connections to equipment.
7. Section 283100 - Fire Detection and Alarm: Automatic fire-alarm and smoke-detection systems.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. National Fire Protection Association:

1. NFPA 13 - Standard for the Installation of Sprinkler Systems.

1.3 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit manufacturer information regarding sprinklers, valves, and specialties.
2. Submit performance ratings, rough-in details, weights, and requirements for supports and piping connections.

C. Shop Drawings:

1. Indicate layout of finished-ceiling areas, indicating sprinkler locations to be coordinated with ceiling installation and ductwork.
2. Indicate detailed pipe layout, hangers and supports, sprinklers, components, and accessories.
3. Indicate system controls.

D. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for following items:

1. Performance requirements and analysis data showing compliance with performance criteria.
2. Data for water supply, hazard assessment, and system design concept.
3. Hydraulic calculations to substantiate compliance with hydraulic design requirements.
4. Hydrant flow test report with static and residual pressures.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.

1.5 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:

1. Record actual locations of sprinklers and deviations of piping from Drawings.
2. Indicate drain and test locations.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials: Furnish extra sprinklers according to NFPA 13.

C. Tools:

1. Furnish suitable operating wrenches for each sprinkler type.
2. Furnish metal storage cabinet located adjacent to main riser.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 13 and requirements of the authority having jurisdiction.
- B. Maintain one copy of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.
- C. Licensed Professional: Professional engineer with National Institute for Certification in Engineering Technologies (NICET) Level 3 certification in water-based systems layout and experienced in design of specified Work, employed by the Installer, and licensed at Project location.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- 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. Furnish piping with temporary inlet and outlet caps until installation.
 - 2. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 3. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Provide coverage for entire building.
- B. Occupancy Requirements: Hydraulically design system to NFPA 13 for hazard level appropriate for occupancy and use of spaces. For bidding purposes, assume all commodities stored in warehouse can be classified as Class I, II, or III.
- C. Volume and Pressure of Water Supply:
 - 1. Source: Hydrant water-flow test data.
- D. Connection Interfaces: Building automatic fire-alarm and smoke-detection system.
- E. Fire-Department Connections: At locations as indicated on Drawings.

2.2 SPRINKLERS

- A. Suspended-Ceiling Type:
 - 1. Type: Recessed pendant sprinklers, with matching clamp-on or screw-on escutcheon plate.
 - 2. Materials:
 - a. Sprinkler: Brass and bronze.
 - b. Escutcheon Plate: Carbon steel.
 - 3. Fusible Link:
 - a. Type: Glass bulb.
 - b. Temperature Rating: As required for specific area hazard.
 - 4. Finishes:
 - a. Sprinkler and Escutcheon Plate: Polyester.
 - b. Color: White.
- B. Exposed-Area Type:
 - 1. Type: Upright sprinklers.
 - 2. Material: Brass.
 - 3. Fusible Link:
 - a. Type: Fusible solder or glass bulb.
 - b. Temperature Rating: As required for specific area hazard.
 - 4. Finishes:

- a. Sprinkler: Brass.

C. Sidewall Type:

1. Type: Recessed, horizontal sidewall with matching clamp-on or screw-on escutcheon plate.
2. Materials:
 - a. Sprinkler: Brass and bronze.
 - b. Escutcheon Plate: Carbon steel.
3. Fusible Link:
 - a. Type: Glass bulb.
 - b. Temperature Rating: As required for specific area hazard.
4. Finishes:
 - a. Sprinkler and Escutcheon Plate: Polyester.
 - b. Color: White.

2.3 PIPING SPECIALTIES

A. Wet-Pipe Sprinkler Check Valve:

1. Type: Swing check.
2. Ductile iron body and cover, stainless steel clapper, spring and hinge shaft, resilient elastomer seal facing on spring-loaded clapper.

B. Water-Flow Switch:

1. Description: Vane type for mounting horizontally or vertically.
2. Contacts:
 - a. Quantity: Two.
 - b. Rating: 10 A at 125 V ac, and 2.5 A at 24 V dc.

C. Fire-Department Connections:

1. Description: Flush-mounted wall type, constructed of brass.
2. Outlets:
 - a. Type: Two way or one way, as required by NFPA 13..
 - b. End Connections:
 - 1) Minimum Size: 2-1/2 inches.
 - 2) Fittings: Threaded swivel type to match fire-department hardware.
 - c. Furnish threaded cap and chain of matching material and finish.
3. Drain:

- a. Type: Automatic drip.
 - b. Size: 3/4 inch.
 - c. Outlet: Connected to building drain.
4. Label: SPRINKLER - FIRE-DEPARTMENT CONNECTION.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that water-flow, pressure, supervisory, and alarm devices are installed and connected to automatic fire-alarm and smoke-detection system.

3.2 INSTALLATION

- A. Comply with NFPA 13.
- B. Clearances:
 - 1. Locate fire-department connection, check valve, and automatic drip with sufficient clearance from walls, obstructions, or adjacent fire-department connections, to allow full swing of fire-department wrench handle.
- C. Piping:
 - 1. Minimize obstructions with other Work.
 - 2. Where possible, install in concealed spaces above finished ceilings.
- D. Center sprinklers in one direction only in ceiling tile with location in other direction variable, dependent upon spacing and coordination with ceiling elements.

3.3 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.
- B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Hydrostatic Testing:
 - 1. Comply with NFPA 13.
 - 2. Witnessing: Authority having jurisdiction.

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3.4 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Flush entire piping system of foreign matter.

3.5 PROTECTION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish.
- C. Remove protection after painting and replace painted sprinklers with new.

END OF SECTION 211313

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flexible pipe connectors.

B. Related Sections:

1. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product and installation requirements for piping hangers and supports.
2. Section 221100 - Facility Water Distribution: Product and installation requirements for piping used in domestic water systems.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.9 - Building Services Piping.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, loops, offsets and swing joints.

C. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

D. Design Data: Indicate criteria and show calculations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Perform Work in accordance with the codes and standards adopted by the authority having jurisdiction.
- C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Copper Piping:
 - 1. Inner Hose: Bronze.
 - 2. Exterior Sleeve: Braided bronze.

3. Pressure Rating: 125 psig WSP and 450 degrees F.
4. Joint: Soldered.
5. Size: Use pipe sized units.
6. Maximum offset: 1 inch on each side of installed center line.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.9.
- B. Install flexible pipe connectors on pipes at locations of building expansion joints. Provide line size flexible connectors.
- C. Install flexible connectors at right angles to displacement. Anchor one end to building at one side of expansion joint and anchor other end to building at other side of expansion joint. Install in horizontal plane unless indicated otherwise.
- D. Rigidly anchor pipe to building structure. Erect piping so strain and weight is not on cast connections or apparatus.

END OF SECTION 220516

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SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Flashing.
4. Sleeves.
5. Formed steel channel.

B. Related Sections:

1. Section 099000 - Painting and Coating: Product and execution requirements for painting specified by this section.
2. Section 221100 - Facility Water Distribution: Execution requirements for placement of hangers and supports specified by this section.
3. Section 221300 - Facility Sanitary Sewerage: Execution requirements for placement of hangers and supports specified by this section.
4. Section 221400 - Facility Storm Drainage: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
2. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:

1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with applicable authority.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Provide ventilation in areas to receive solvent cured materials.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Plumbing Piping - DWV:

1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
6. Vertical Support: Steel riser clamp.
7. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

- B. Plumbing Piping - Water:

1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Vertical Support: Steel riser clamp.

2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.

- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Flexible Flashing: compatible with roofing.
- D. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Acrylic.

2.6 FORMED STEEL CHANNEL

- A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.

3.2 PREPARATION

- A. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- B. Do not drill or cut structural members.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1, ASME B31.5, ASME 31.9, ASTM F708, MSS SP 58, MSS SP 69, MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.

- F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- I. Support riser piping independently of connected horizontal piping.
- J. Provide copper plated hangers and supports for copper piping.
- K. Design hangers for pipe movement without disengagement of supported pipe.
- L. Prime coat exposed steel hangers and supports. Refer to Section 099000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.

3.4 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
- C. Seal floor, shower, and mop sink drains watertight to adjacent materials.
- D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.5 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with stuffing insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

- F. Install chrome plated steel escutcheons at finished surfaces.

3.6 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting, testing.

3.7 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

3.8 PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.9 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Pipe Material: Cast iron.
 - a. Maximum Hanger Spacing: 5 feet.
 - b. Hanger Rod Diameter: 5/8 inch.
 - 2. Pipe Material: Cast Iron, with 10-foot length of pipe.
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 5/8 inch.
 - 3. Pipe Material: Copper tube.
 - a. Size: 1-1/4 inches and smaller.
 - b. Maximum Hanger Spacing: 6 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 - 4. Pipe Material: Copper tube.
 - a. Size: 1-1/2 inches and larger.
 - b. Maximum Hanger Spacing: 10 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 - 5. Pipe Material: PVC.
 - a. Maximum Hanger Spacing: 4 feet.
 - b. Hanger Rod Diameter: 3/8 inch.

6. Pipe Material: Steel.
 - a. Size: 3 inches and smaller.
 - b. Maximum Hanger Spacing: 12 feet.
 - c. Hanger Rod Diameter: 1/2 inch.

END OF SECTION 220529

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.

B. Related Sections:

1. Section 099000 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Plastic Tags:
 - 1. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
- B. Metal Tags:
 - 1. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- C. Information Tags:
 - 1. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- D. Tag Chart: Typewritten letter size list of applied tags and location, plastic laminated.

2.3 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
 - 2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
 - 3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
 - 4. Ductwork and Equipment: 1-3/4 inches high letters.
- B. Stencil Paint: As specified in Section 099000, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers
 - 1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Tape Pipe Markers
 - 1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Plastic Underground Pipe Markers
 - 1. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.5 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color-coded head.
- B. Color code as follows:
 - 1. Plumbing valves: Green.

2.6 LABELS

- A. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

- B. Prepare surfaces in accordance with Section 099000 for stencil painting.

3.2 INSTALLATION

- A. Apply stencil painting in accordance with Section 099000.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain. Number tags consecutively by location.
- F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- G. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates or stencil painting. Identify in-line pumps and other small devices with tags.
- H. Identify control panels and major control components outside panels with plastic nameplates.
- I. Identify valves in main and branch piping with tags.
- J. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- K. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plumbing piping insulation, jackets and accessories.
2. Plumbing equipment insulation, jackets and accessories.

B. Related Sections:

1. Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.2 REFERENCES

A. ASTM International:

1. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
2. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
3. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
4. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
5. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
6. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
7. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
8. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
9. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120.
10. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

1.4 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- D. Perform Work in accordance with codes and standards adopted by authority having jurisdiction.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Glass Fiber and Mineral Fiber Insulation

2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
 - 1. Thermal Conductivity: 0.23 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 850 degrees F.
 - 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- B. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F.
 - 2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

- A. Vapor Retarder Jacket:
 - 1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
- B. PVC Plastic Pipe Jacket:
 - 1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
 - 2. Thickness: 10 mil.
 - 3. Connections: Brush on welding adhesive.

2.4 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

- D. Piping 2 inches diameter and larger: High density non-compressible insulation. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.
- E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum or stainless steel jacket single piece construction with self adhesive closure. Thickness to match pipe insulation.
- F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
- H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

- A. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft reinforced aluminum foil jacket.
 - 1. Thermal Conductivity: 0.24 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 450 degrees F.
 - 3. Density: 3.0 pound per cubic foot.
 - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.

2.6 EQUIPMENT INSULATION JACKETS

- A. PVC Plastic Equipment Jacket:
 - 1. Product Description: ASTM D1785, sheet material, off-white color.
 - 2. Minimum Service Temperature: -40 degrees F.
 - 3. Maximum Service Temperature: 150 degrees F.
 - 4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
 - 5. Thickness: 10 mil.
 - 6. Connections: Brush on welding adhesive.

2.7 EQUIPMENT INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
- E. Adhesives: Compatible with insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping and equipment has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Finish at supports, protrusions, and interruptions.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- D. Glass Fiber Board Insulation:
 - 1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
 - 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.
- E. Hot Piping Systems less than 140 degrees F:
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
 - 3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.
- F. Hot Piping Systems greater than 140 degrees F:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

G. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

H. Insulation Terminating Points:

1. Condensate Piping: Insulate entire piping system and components to prevent condensation.

I. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping. Do not use pre-slit insulation.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings with insulation of like material and thickness as adjacent pipe.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

K. Buried Piping:

1. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.
- OR -
2. Install flexible, closed cell elastomeric insulation, and cover with corrugated HDPE sleeve pipe to prevent insulation from being compressed.

3.3 INSTALLATION - EQUIPMENT

- A. Factory Insulated Equipment: Do not insulate.
- B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

- C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- D. Equipment Containing Fluids Below Ambient Temperature:
 - 1. Insulate entire equipment surfaces.
 - 2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 4. Finish insulation at supports, protrusions, and interruptions.
- E. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
- F. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

3.4 SCHEDULES

- A. Water Supply Services Piping Insulation Schedule:
 - 1. Domestic Hot Water Supply and Recirculation:
 - a. Type: P-1.
 - b. Thickness: 1.0 inch.
 - 2. Domestic Cold Water Above Ceilings and Anywhere Concealed:
 - a. Type: P-1.
 - b. Thickness: 0.5 inch.
 - 3. Domestic Cold Water Exposed in Warehouse not Above Ceilings:
- B. Drainage Services Piping Insulation Schedule:
 - 1. Storm Piping - Horizontal and Vertical Above Ground Within Building:
 - a. Type: P-1.
 - b. Thickness: 1.0 inch.
- C. Equipment Insulation Schedule:
 - 1. Roof Drain Bodies:
 - a. Type: E-2.
 - b. Thickness: 1 inch.

END OF SECTION 220700

SECTION 221100 - FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Domestic water piping, within 5 feet of building.
2. Domestic water piping, above grade.
3. Unions and flanges.
4. Valves.
5. Pressure gages.
6. Pressure gage taps.
7. Thermometers.
8. Water pressure reducing valves.
9. Strainers.
10. Hose bibs.
11. Hydrants.
12. Recessed valve box.
13. Backflow preventers.
14. Water hammer arrestors.
15. Diaphragm-type compression tanks.
16. System lubricated circulators.
17. Underground pipe markers.
18. Bedding and cover materials.

B. Related Sections:

1. Section 083113 - Access Doors and Frames: Product requirements for access doors for placement by this section.
2. Section 099000 - Painting and Coating: Product and execution requirements for painting specified by this section.
3. Section 220516 - Expansion Fittings and Loops for Plumbing Piping: Execution requirements for pipe expansion devices for placement by this section.
4. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports [**and firestopping**] for placement by this section.
5. Section 220553 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification and valve tags for placement by this section.
6. Section 220700 - Plumbing Insulation: Product and execution requirements for pipe insulation.
7. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.
8. Section 310513 - Soils for Earthwork: Soils for backfill in trenches.
9. Section 310516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
10. Section 312316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
11. Section 312316.13 - Trenching: Execution requirements for trenching required by this section.

12. Section 312323 - Fill: Requirements for backfill to be placed by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
3. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
4. ASME B31.9 - Building Services Piping.
5. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
6. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Society of Sanitary Engineering:

1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
2. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
3. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
4. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type.
5. ASSE 5013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers (RP) and Reduced Pressure Fire Protection Principle Backflow Preventers (RFP).

C. ASTM International:

1. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
2. ASTM B32 - Standard Specification for Solder Metal.
3. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
5. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
6. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
7. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120.
8. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameters.
9. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
10. ASTM D2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
11. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
12. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
13. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.

14. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
15. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
16. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
17. ASTM E1 - Standard Specification for ASTM Thermometers.
18. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
19. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
20. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
21. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
22. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
23. ASTM F442/F442M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
24. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

D. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

E. American Water Works Association:

1. AWWA C651 - Disinfecting Water Mains.
2. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
2. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

G. Plumbing and Drainage Institute:

1. PDI WH201 - Water Hammer Arrester Standard.

H. Underwriters Laboratories Inc.:

1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturer's catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
4. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves and equipment.
- C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

1.5 QUALITY ASSURANCE

- A. For drinking water service, provide valves complying with NSF 61.
- B. Perform Work in accordance with codes adopted by the authority having jurisdiction.
- C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.

- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Tubing: ASTM B88, Type L, annealed.
 - 1. Fittings: ASME B16.22, wrought copper.
 - 2. Joints: Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L, drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, solder

2.3 FLUE AND COMBUSTION AIR PIPING

- A. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material.
 - 1. Fittings: ASTM D2466, Schedule 40, PVC.

2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement. Prime joints with a contrasting color.
- B. CPVC Pipe: ASTM F441/F441M, Schedule 40, chlorinated polyvinyl chloride (CPVC) material.
1. Fittings: ASTM F438, CPVC, Schedule 40, socket type.
 2. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement. Prime joints with a contrasting color.

2.4 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
1. Copper Piping: Class 150, bronze unions with soldered or brazed joints.
 2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.5 BALL VALVES

- A. BA-1 2 inches and Smaller: MSS SP 110, 400 psi WOG, two piece bronze body, chrome plated brass ball, full port, teflon seats, blow-out proof stem, solder ends, lever handle.
- B. BA-2 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, chrome plated bronze ball, full port, teflon seats, blow-out proof stem, solder ends, lever handle.

2.6 CHECK VALVES

- A. Horizontal Swing Check Valves:
1. CK-1 2 inches and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N disc, solder or threaded ends.
- B. Spring Loaded Check Valves:
1. CK-6 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.

2.7 PRESSURE GAGES

- A. Gage: ASME B40.1, UL 393 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
1. Case: Steel, stainless steel or ABS.
 2. Bourdon Tube: Brass or Phosphor bronze.
 3. Dial Size: 2-1/2 inch or larger diameter.
 4. Mid-Scale Accuracy: two percent.

5. Scale: Psi.

2.8 PRESSURE GAGE TAPS

- A. Ball Valve: Brass or stainless Steel, 1/8 inch NPT or 1/4 inch NPT for 250 psi.

2.9 STEM TYPE THERMOMETERS

- A. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
 1. Size: 9 inch scale.
 2. Window: Clear glass or Lexan.
 3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
 4. Accuracy: ASTM E77 2 percent.
 5. Calibration: Degrees F.

2.10 WATER PRESSURE REDUCING VALVES

- A. 2 inches and Smaller: MSS SP 80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded and single union ends.

2.11 STRAINERS

- A. 2 inch and Smaller: Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

2.12 HOSE BIBS

- A. Interior: Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with hand wheel, vacuum breaker in conformance with ASSE 1011.

2.13 HYDRANTS

- A. HB-1 Wall Hydrant: ASSE 1019; non-freeze, self-draining type with round chrome plated lockable recessed box hose thread spout, locks shield and removable key, and integral vacuum breaker, Woodford model RB67 or equivalent.
- B. HB-2 Wall Hydrant: ASSE 1011; anti-siphon vacuum breaker protected wall faucet, EPDM packing, adjustable packing nut, polycarbonate or metal wheel handle, Woodford model 24P-3/4 or equivalent.

2.14 WB-1 RECESSED VALVE BOX

- A. Refrigerator: Plastic preformed rough-in box with brass ball valve with handle, slip in finishing cover, and water hammer arrestor.

2.15 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers:
 - 1. Comply with ASSE 1013.
 - 2. Bronze body, with bronze internal parts and stainless steel springs.
 - 3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two ball valves, strainer, and four test cocks.

2.16 WATER HAMMER ARRESTORS

- A. ASSE 1010; copper construction, piston type sized in accordance with PDI WH-201.
- B. Pre-charged suitable for operation in temperature range 34 to 250 degrees F and maximum 150 psi working pressure.

2.17 ET-1 BLADDER-TYPE COMPRESSION TANKS

- A. Construction: ASME replaceable bladder type, carbon steel shell and heads, butyl bladder, stainless steel system connection, maximum design pressure of 150 psig, maximum design temperature of 240°F.
- B. Accessories: Air-charging fitting; pre-charge to 75 psig.
- C. Size: 6.5 gallon acceptance volume for initial pressure of 75 psig, 23 gallon tank volume, Wessels model TXA-85 or equivalent.

2.18 ET-2 DIAPHRAGM-TYPE COMPRESSION TANKS

- A. Construction: Carbon steel, butyl diaphragm, Epitaxial liner, stainless steel system connection, maximum design pressure of 150 psig, maximum design temperature of 210°F.
- B. Accessories: Air-charging fitting; pre-charge to 75 psig.
- C. Size: 2.9 gallon acceptance volume, 4.8 gallon tank volume, Wessels model T-12 or equivalent.

2.19 SYSTEM LUBRICATED CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected with single speed or multiple speed wet rotor motor for in-line mounting, for 140 psig maximum working pressure, 230 degrees F maximum water temperature.
- B. Casing: Bronze or stainless steel with flanged pump connections.
- C. Impeller, Shaft, Rotor: Stainless Steel on non-metallic.
- D. Bearings: Metal Impregnated carbon (graphite) and ceramic.
- E. Motor: Impedance protected, multiple single or three speed.
- F. Performance:
 - 1. Flow Capacity: 5 gal/min.
 - 2. Head: 13 feet.
- G. Electrical Characteristics: In accordance with Section 260503 and the following:
 - 1. 1/25 hp, 0.84 rated load amperes.
 - 2. 115 volts, single phase, 60 Hz.
- H. Manufacturer and model: Taco model 008-BF6 or equivalent.
- I. Accessories:
 - 1. Programmable 7-day time clock.
 - 2. Cord and plug.

2.20 UNDERGROUND PIPE MARKERS

- A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Domestic Water Service" in large letters.

2.21 BEDDING AND COVER MATERIALS

- A. Bedding: Comply with codes and standards adopted by the authority having jurisdiction.
- B. Cover: Comply with codes and standards adopted by the authority having jurisdiction.
- C. Soil Backfill from Above Pipe to Finish Grade: Comply with codes and standards adopted by the authority having jurisdiction. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.

3.3 INSTALLATION - THERMOMETERS AND GAGES

- A. Install gage taps in piping.
- B. Install pressure gages with ball valve to isolate each gage.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- D. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- E. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- F. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.4 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection size, location, and invert are as indicated on Drawings.
- B. Remove scale and dirt on inside of piping before assembly.
- C. Excavate pipe trench in accordance with Section 312316.
- D. Install pipe to elevation as indicated on Drawings.
- E. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- F. Install pipe on prepared bedding.
- G. Route pipe in straight line.

- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- I. Install trace wire continuous over top of pipe. buried 6 inches below finish grade, above pipe line; coordinate with Section 312323. Refer to Section 220553.
- J. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Section 312323 and applicable codes.
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 5. Do not use wheeled or tracked vehicles for tamping.

3.5 INSTALLATION - ABOVE GROUND PIPING

- A. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- C. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- D. Group piping whenever practical at common elevations.
- E. Slope piping and arrange systems to drain at low points.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 220700.
- H. Provide access where valves and fittings are not accessible.
- I. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.
- J. Install domestic water piping in accordance with ASME B31.9.
- K. Sleeve pipes passing through partitions, walls and floors. Refer to Section 220529.
- L. Install valves with stems upright or horizontal, not inverted.
- M. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- N. Install ball valves for throttling, bypass, or manual flow control services.

- O. Provide spring loaded check valves on discharge of water pumps.
- P. Install potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.
- Q. Pipe relief from valves, back-flow preventers and drains to nearest floor drain or where indicated on Drawings.
- R. Test backflow preventers in accordance with ASSE 5013.
- S. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to electrically operated valves, lavatories, sinks, warewashing machine outlets, flush valves.

3.6 INSTALLATION - SERVICE CONNECTIONS

- A. Provide new water service complete with approved reduced pressure back-flow preventer and pressure reducing valves, and strainer.
- B. Provide 18 gage galvanized sheet metal sleeve around service main to 6 inch above floor and 3 feet minimum below grade. Size for minimum of 2 inches of loose batt insulation stuffing.

3.7 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements and Section 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test domestic water piping system in accordance with applicable code and local authority having jurisdiction.

3.8 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Disinfect water distribution system in accordance with applicable code.
- C. Prior to starting work, verify system is complete, flushed and clean.
- D. Verify pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- E. Inject disinfectant, free chlorine in liquid, powder and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.
- F. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.
- G. Maintain disinfectant in system for 24 hours.

- H. When final disinfectant residual tests less than 25 mg/L, repeat treatment.
- I. Flush disinfectant from system until residual concentration is equal to incoming water or 1.0 mg/L.
- J. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION 221100

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SECTION 221300 - FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sanitary sewer piping buried within 5 feet of building.
2. Sanitary sewer piping above grade.
3. Floor drains.
4. Floor sinks.
5. Cleanouts.
6. Interceptors.
7. Bedding and cover materials.

B. Related Sections:

1. Section 033000 - Cast-In-Place Concrete: Execution requirements for placement of concrete specified by this section.
2. Section 083113 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 099000 - Painting and Coating: Product and execution requirements for painting specified by this section.
4. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports [**and firestopping**] for placement by this section.
5. Section 310513 - Soils for Earthwork: Soils for backfill in trenches.
6. Section 310516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
7. Section 312316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
8. Section 312316.13 - Trenching: Execution requirements for trenching required by this section.
9. Section 312323 - Fill: Requirements for backfill to be placed by this section.
10. Section 334100 - Storm Utility Drainage Piping: Catch basins and manholes.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A112.14.3 - Grease Interceptors.
2. ASME A112.14.4 - Grease Removal Devices.
3. ASME A112.21.1 - Floor Drains.
4. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

3. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
4. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
5. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
6. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
7. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
8. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

C. Cast Iron Soil Pipe Institute:

1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

D. Plumbing and Drainage Institute:

1. PDI G101 - Standard - Testing and Rating Procedure for Grease Interceptors.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of equipment and clean-outs.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with codes adopted by authority having jurisdiction.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. PVC Pipe: ASTM D2665, polyvinyl chloride (PVC) material.
 - 1. Fittings: PVC, ASTM D2665 or ASTM D3034.
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.2 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hub-less, service weight.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- C. PVC Pipe: ASTM D2665, polyvinyl chloride (PVC) material.
 - 1. Fittings: ASTM D2665, PVC.
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
 - 3. PVC pipe and fittings shall not be installed in return air plenum above ceilings.

2.3 FLOOR DRAINS

- A. Floor Drain (FD-1): ASME A112.21.1; lacquered or galvanized cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer, Zurn model ZN415B or equivalent. Provide with rubber trap seal.
- B. Floor Drain (FD-2): ASME A112.21.1; lacquered or galvanized cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with raised flange, Zurn model ZN415I or equivalent.
- C. Floor Drain (FD-3): ASME A112.21.1 and U.S. FDA standards; 6-1/4 inch diameter 3 inch deep, 12 gauge type 304 stainless steel, round drain with light-duty perforated grate and sediment basket; Zurn model Z1786-Y or equivalent.

2.4 FLOOR SINKS

- A. Floor Sink (FS-1): Square cast iron body with integral seepage pan, white porcelain enamel interior and top, sediment basket, clamp collar, white porcelain enamel coated cast iron 3/4 grate, and aluminum sediment bucket; Zurn model Z1901-K-3-23 or equivalent.

2.5 CLEANOUTS

- A. Exterior Surfaced Areas (CO-1): Round cast nickel bronze access frame and non-skid cover.
- B. Exterior Unsurfaced Areas (CO-2): Line type with lacquered cast iron body and round epoxy coated cover with gasket.
- C. Interior Finished Floor Areas (CO-3): Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round depressed cover with gasket to accept floor finish in finished floor areas.

- D. Interior Finished Wall Areas (CO-4): Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.
- E. Interior Unfinished Accessible Areas (CO-5): Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.6 GI-1 GREASE INTERCEPTORS

- A. Comply with ASME A112.14.6.
- B. Construction:
 - 1. Material: Precast reinforced concrete, 5000 psi minimum strength, monolithic poured floor, H-20 loading, 24 inch diameter concrete manhole extensions, and manhole rings.
- C. Cover: Two cast iron manhole covers.
- D. Unit Rating: 2500 gallons with two compartments divided into 2/3 and 1/3 of capacity.
- E. Accessories: Contractor shall configure and pipe interceptor as indicated in *Grease Interceptor Detail* on drawings.
- F. Manufacturer: Copeland Enterprises Inc., Denver, CO or equivalent.

2.7 BEDDING AND COVER MATERIALS

- A. Bedding: Comply with codes and standards adopted by the authority having jurisdiction.
- B. Cover: Comply with codes and standards adopted by the authority having jurisdiction.
- C. Soil Backfill from Above Pipe to Finish Grade: Comply with codes and standards adopted by the authority having jurisdiction. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.

- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection size, location, and invert are as indicated on Drawings.
- B. Remove scale and dirt on inside of piping before assembly.
- C. Excavate pipe trench in accordance with Section 312316.
- D. Install pipe to elevation as indicated on Drawings.
- E. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- F. Install pipe on prepared bedding.
- G. Route pipe in straight line.
- H. Install trace wire continuous over top of pipe. buried 6 inches below finish grade, above pipe line; coordinate with Section 312323. Refer to Section 220553.
- I. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Section 312323 and applicable codes and standards.
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 5. Do not use wheeled or tracked vehicles for tamping.

3.4 INSTALLATION - ABOVE GROUND PIPING

- A. PVC pipe and fittings shall not be installed in return air plenum above ceilings.
- B. Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum. Maintain gradients.
- C. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearances at cleanout for snaking drainage system.
- D. Encase exterior cleanouts in concrete flush with grade.
- E. Install floor cleanouts at elevation to accommodate finished floor.

- F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- G. Install piping to maintain headroom. Do not spread piping, conserve space.
- H. Group piping whenever practical at common elevations.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.
- K. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 083113.
- L. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.
- N. Install bell and spigot pipe with bell end upstream.
- O. Sleeve pipes passing through partitions, walls and floors.
- P. Support cast iron drainage piping at every joint.

3.5 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements.
- B. Test sanitary waste and vent piping system in accordance with applicable code and local authority having jurisdiction.

END OF SECTION 221300

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SECTION 221400 - FACILITY STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Storm water piping buried within 5 feet of building.
2. Storm water piping above grade.
3. Roof drains.
4. Downspout nozzles.
5. Cleanouts.
6. Bedding and cover materials.

B. Related Sections:

1. Section 033000 - Cast-in-Place Concrete: Execution requirements for placement of concrete specified by this section.
2. Section 083113 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 099000 - Painting and Coating: Execution requirements for painting material specified by this section.
4. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports [**and firestopping**] for placement by this section.
5. Section 220553 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
6. Section 220700 - Plumbing Insulation: Product and execution requirements for pipe insulation.
7. Section 310513 - Soils for Earthwork: Soils for backfill in trenches.
8. Section 310516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
9. Section 312316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
10. Section 312316.13 - Trenching: Execution requirements for trenching required by this section.
11. Section 312323 - Fill: Requirements for backfill to be placed by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A112.21.2M - Roof Drains.
2. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

2. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
3. ASTM D1785 - Standard Specification for (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
4. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
5. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
6. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
7. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
8. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
9. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
10. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
11. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
12. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
13. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 2. Storm Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of equipment and cleanouts.

1.5 QUALITY ASSURANCE

- A. Perform Work according to codes and standards adopted by authority having jurisdiction.

- B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.
 - 1. Fittings: PVC, ASTM D2665 or ASTM D3034.

2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.2 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 1. Fittings: Cast iron, CISPI 301.
 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.
- B. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.
 1. Fittings: ASTM D2665 or ASTM D3034, PVC.
 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
 3. PVC pipe and fittings shall not be installed in return air plenum above ceilings.

2.3 ROOF DRAINS

- A. Roof Drain (RD-1):
 1. Assembly: ASME A112.21.2M.
 2. Body: 12 inch lacquered or galvanized cast iron with sump.
 3. Strainer: Removable cast metal dome.
 4. Accessories: Coordinate with roofing type:
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 5. Manufacture and model: Zurn ZC121 series or equivalent.
- B. Roof Drain (RD-2):
 1. Assembly: ASME A112.21.2M.
 2. Body: 12 inch lacquered or galvanized cast iron with sump.
 3. Strainer: Removable cast metal dome.
 4. Pipe extended to 2 inches above flood elevation.
 5. Accessories: Coordinate with roofing type:
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 6. Manufacture and model: Zurn ZC121 series or equivalent.

2.4 DOWNSPOUT NOZZLES

- A. Product Description: Polished bronze body and wall flange round with straight bottom section, Manufacturer Zurn Z199 series or equivalent.

2.5 CLEANOUTS

- A. Exterior Surfaced Areas (CO-1): Round cast nickel bronze access frame and non-skid cover.

- B. Exterior Unsurfaced Areas (CO-2): Line type with lacquered cast iron body and round epoxy coated cover with gasket.
- C. Interior Finished Wall Areas (CO-4): Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.
- D. Interior Unfinished Accessible Areas (CO-5): Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.6 BEDDING AND COVER MATERIALS

- A. Bedding: Comply with applicable code and standards.
- B. Cover: Comply with applicable code and standards.
- C. Soil Backfill from Above Pipe to Finish Grade: Comply with applicable code and standards. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than 3 ft of cover.
- C. Excavate pipe trench according to Section 312316.
- D. Install pipe to elevation as indicated on Drawings.

- E. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- F. Install pipe on prepared bedding.
- G. Route pipe in straight line.
- H. Install trace wire continuous over top of pipe above pipe line; coordinate with Section 312323. Refer to Section 220553.
- I. Pipe Cover and Backfilling:
 - 1. Backfill trench according to Section 312323.
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 5. Do not use wheeled or tracked vehicles for tamping.

3.4 INSTALLATION - ABOVE GROUND PIPING

- A. PVC pipe and fittings shall not be installed in return air plenum above ceilings.
- B. Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum. Maintain gradients.
- C. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearance at cleanout for snaking drainage system.
- D. Encase exterior cleanouts in concrete flush with grade.
- E. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- F. Install piping to maintain headroom. Group piping to conserve space.
- G. Group piping whenever practical at common elevations.
- H. Support cast iron drainage piping at every joint.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.
- K. Provide access where valves and fittings are not accessible.

- L. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.
- N. Install bell and spigot pipe with bell end upstream.
- O. Sleeve pipes passing through partitions, walls and floors. Refer to Section 220529.

3.5 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirement.
- B. Test storm drainage piping system according to applicable code and local authority having jurisdiction.

END OF SECTION 221400

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SECTION 223300 - ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Commercial electric water heaters.
- B. Related Sections:
 - 1. Section: 221100 - Facility Water Distribution: Supply connections to domestic water heaters.
 - 2. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections specified by this Section.

1.2 REFERENCES

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. American Society of Mechanical Engineers:
 - 1. ASME PTC 25 - Pressure Relief Devices.
 - 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Submit electrical characteristics and connection locations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.5 QUALITY ASSURANCE

- A. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1.

- B. Perform Work according to authority having jurisdiction.
- C. Maintain one copy of each document on Site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Products storage and handling requirements.
- B. Accept water heaters on Site in original labeled cartons. Inspect for damage.
- C. Protect tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer warranty for water heater tanks.

PART 2 - PRODUCTS

2.1 RESIDENTIAL ELECTRIC WATER HEATERS WH-3

- A. Type: Factory-assembled and wired, electric, vertical storage.
- B. Capacity:
 - 1. Storage Capacity: 28 gal.

2. Heating Element Size: 2 @ 4.5 kW non-simultaneous elements.
 3. Minimum Recovery Rate: 19 gph with 100 degrees F temperature rise.
 4. Maximum Working Pressure: 150 psig.
- C. Tank: Glass lined welded steel; thermally insulated with minimum 1-inch thick polyurethane encased in corrosion-resistant steel jacket; baked-on enamel finish.
- D. Controls: Automatic surface-mount water thermostat; externally adjustable temperature range from up to at least 140 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
- E. Accessories: True dielectric water connections, dip tube, brass drain valve, magnesium anode, and ASME rated temperature and pressure relief valve, 2 inch thick insulation blanket.
- F. Manufacturer and model: Bradford White RE230L6 or equivalent.

2.2 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: According to Section 260503 and the following:
1. 480 V, three phase, 60 Hz.
 2. 15 A maximum overcurrent protection.
- B. Disconnect Switch: Provided by Electrical Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Maintain manufacturer's recommended clearances around and over water heaters.
- B. Connect domestic hot and cold water piping to supply and return water heater connections.
- C. Install discharge piping from relief valves and drain valves to nearest floor drain.
- D. Install water heater trim and accessories furnished loose for field mounting.
- E. Install electrical devices furnished loose for field mounting.

END OF SECTION 223300

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SECTION 223400 - FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial gas-fired water heaters.

B. Related Sections:

1. Section 033000 - Cast-in-Place Concrete: Execution requirements for concrete housekeeping pads specified by this Section.
2. Section 220700 - Plumbing Insulation: Field applied insulation for domestic water heaters.
3. Section: 221100 - Facility Water Distribution: Supply connections to domestic water heaters.
4. Section 231123 - Facility Natural-Gas Piping: Execution requirements for gas piping connections specified by this Section.
5. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections specified by this Section.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.10.3 - Gas Water Heaters - Vol. III Storage, with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous Water Heaters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:

1. ASME PTC 25 - Pressure Relief Devices.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data:

1. Water Heaters: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements. Submit electrical characteristics and connection locations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.5 QUALITY ASSURANCE

- A. Conform to ASME Section VIII for construction of water heaters. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.
- B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested according to ANSI Z21.10.3.
- C. Perform Work according to codes adopted by the authority having jurisdiction.

PART 2 - PRODUCTS

2.1 COMMERCIAL GAS FIRED WATER HEATERS WH-1 AND WH-2

- A. Type: Automatic, natural gas-fired, vertical storage certified by CSA International to ANSI standard Z-21.10.3 for up to 180°F application as an Automatic Storage Heater.
- B. Capacity:
 1. Storage Capacity: 98 gal.
 2. Input: 399,999 Btuh at sea level.
 3. Minimum Recovery Rate: 398 gph with 100 degrees F temperature rise at sea level.
 4. Thermal Efficiency: 83% at sea level
 5. Maximum Working Pressure: 150 psig.
 6. Certification: ANSI Z21.10.3.
- C. Tank: Glass-lined welded steel ASME labeled; multiple flue passages, 4-inch diameter inspection port, thermally insulated with minimum 2 inches of polyurethane or equivalent, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
- D. Accessories: Brass water connections and dip tube, drain valve, magnesium anode, ASME rated temperature and pressure relief valve, and connection for piped combustion air.
- E. Controls: Digital controls with LCD display, automatic water thermostat with adjustable temperature range from 120 to 180 degrees F. Automatic reset high temperature limiting thermostat factory set at 195 degrees F, gas pressure regulator, premix power burner, direct spark ignition, PVC combustion air pipe and Type B Vent combustion exhaust piped to and from outdoors.

- F. Electrical Requirements: 120V/1PH/60HZ, 1.8 Amp, MOCP 15 Amps.
- G. Manufacturer and model: Bradford White UCG-100H-399-3A or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's installation requirements.
- B. Maintain manufacturer's recommended clearances around and over water heaters.
- C. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side. Refer to Section 033000.
- D. Connect natural gas piping according to NFPA 54.
- E. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service. Accessories shall include shutoff valve, union, gas pressure regulator, pressure gauge tees, and sediment trap. Refer to piping detail on Drawings.
- F. Connect domestic hot and cold water piping to supply and return water heater connections. Refer to piping detail on Drawings.
- G. Pipe combustion air from location indicated on Drawings using PVC pipe of size recommended by water heater manufacturer.
- H. Pipe combustion exhaust to location indicated on Drawings using Type B Vent of size recommended by water heater manufacturer.

END OF SECTION 223400

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SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Service sinks.
6. Electric water coolers.
7. Showers.

B. Related Sections:

1. Section 221100 - Facility Water Distribution: Supply connections to plumbing fixtures.
2. Section 221300 - Facility Sanitary Sewerage: Waste connections to plumbing fixtures.
3. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this Section.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ANSI Z124.2 - Plastic Shower Units.

B. Air-Conditioning and Refrigeration Institute:

1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.

C. American Society of Mechanical Engineers:

1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
2. ASME A112.18.1 - Plumbing Fixture Fittings.
3. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
4. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
5. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

- B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit fixture, trim, exploded view, and replacement parts lists.

1.5 QUALITY ASSURANCE

- A. Perform Work according to codes adopted by the authority having jurisdiction.
- B. Provide products requiring electrical connections listed and classified by UL as suitable for purpose specified and indicated.
- C. Provide plumbing fixture fittings according to ASME A112.18.1 that prevent backflow from fixture into water distribution system.
- D. Maintain one copy of each document on Site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Accept fixtures on Site in factory packaging. Inspect for damage.
- C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 WC-1 FLUSH VALVE WATER CLOSETS

- A. Bowl: ASME A112.19.2M; ADA compliant floor mounted, siphon jet 17-inch bowl height, ADA accessible vitreous china closet bowl, with elongated rim, 12 inch rough-in, 1-1/2-inch top spud, china bolt caps, Kohler model K-96057 or equivalent.
- B. Sensor Operated Flush Valve: ASME A112.18.1; exposed chrome-plated brass, diaphragm type with battery powered sensor operated solenoid, infrared sensor and over-ride button, stop and vacuum breaker; maximum 1.28 gal. flush volume, Sloan model Regal 111 SFSM-1.28 or equivalent.
- C. Seat: Solid white plastic, open front, extended back, self-sustaining hinge, brass or stainless-steel bolts, without cover.

2.2 WC-2 FLUSH VALVE WATER CLOSETS

- A. Bowl: ASME A112.19.2M; floor mounted, siphon jet 17-inch bowl height, ADA accessible vitreous china closet bowl, with elongated rim, 12 inch rough-in, 1-1/2-inch top spud, china bolt caps, Kohler model K-96053 or equivalent.
- B. Sensor Operated Flush Valve: ASME A112.18.1; exposed chrome-plated brass, diaphragm type with battery powered sensor operated solenoid operator, infrared sensor and over-ride button, stop and vacuum breaker; maximum 1.28 gal. flush volume, Sloan model Regal 111 SFSM-1.28 or equivalent.
- C. Seat: Solid white plastic, open front, extended back, self-sustaining hinge, brass or stainless-steel bolts, without cover.

2.3 UR-1 WALL HUNG URINALS

- A. Urinal: ASME A112.19.2M or ANSI Z124.9, vitreous; vitreous china, wall hung washout urinal with shields, integral trap, 3/4-inch top spud, steel supporting hanger, Kohler model K-4991-ET or equivalent.
- B. Sensor Operated Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with battery operated solenoid operator, infrared sensor and over-ride button, stop and vacuum breaker; maximum 0.125 gal. flush volume, Sloan model Regal 186 SFSM-0.125 or equivalent.
- C. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

- D. Provide elastomeric gasket complying with ASME A112.4.3, or approved setting compound, for fixture to flange connection.

2.4 LV-1 LAVATORIES

- A. Undercounter Lavatory: ASME A112.19.2M; ADA compliant vitreous china, unglazed rim for under counter mount with front overflow, 19.25 by 16.25 inches, Kohler model K2210 or equivalent.
- B. Supply Fitting: ASME A112.18.1; ADA compliant chrome-plated supply fitting with water economy laminar spray with maximum 0.35 gpm flow, battery operated solenoid operator, infrared sensor, all components located above deck, Sloan model EAF-250-BAT-CP-0.35GPM-MLM-IR-IQ-FCT or equivalent.
- C. Waste Fittings: ASME A112.18.2 or ASTM F 409.
- D. For hand washing facilities, provide tempered water through regulating device conforming to ASSE 1070.
- E. Accessories:
 - 1. Chrome-plated 17-gage brass P-trap and arm with escutcheon.
 - 2. Waste with plug and strainer.
 - 3. Metal ball valve stops, Brasscraft KT series.
 - 4. Flexible supplies.
 - 5. Trap and waste insulated to meet ADA compliance.

2.5 LV-2 LAVATORIES

- A. Vitreous China Wall Hung Basin: ASME A112.19.2M; ADA compliant vitreous china wall hung lavatory 18-5/16 by 19.75 inches minimum, with oval basin, rear overflow, rear raised lip, single drilling centered, rectangular overall, faucet deck depression, and plumbing shroud, Kohler model K-1999-1 or equivalent.
- B. Supply Fitting: ASME A112.18.1; ADA compliant chrome-plated supply fitting with water economy laminar spray with maximum 0.35 gpm flow, battery operated solenoid operator, infrared sensor, all components located above deck, Sloan model EAF-250-BAT-CP-0.35GPM-MLM-IR-IQ-FCT or equivalent.
- C. Waste Fittings: ASME A112.18.2 or ASTM F 409.
- D. For hand washing facilities, provide tempered water through regulating device conforming to ASSE 1070.
- E. Accessories:
 - 1. Chrome-plated 17-gage brass P-trap and arm with escutcheon.
 - 2. Waste with plug and strainer.
 - 3. Metal ball valve stops, Brasscraft KT series Flexible supplies.
 - 4. Trap and waste insulated to meet ADA compliance.

- F. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

2.6 SINKS

- A. SK-1 Double Compartment Bowl: ASME A112.19.3; ADA compliant 14 by 14 by 5.5 inches bowl dimensions 18-gage thick, Type 304 stainless steel. undermount and undercoated, with 1-1/2-inch stainless-steel drains 3-1/2-inch crumb cups and tailpieces, Elkay model ELUHAD321655PD or equivalent.
- A. SK-2 Single Compartment Bowl: ASME A112.19.3; ADA compliant 16.5 by 16.5 by 5.375 inches bowl dimensions, 18-gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2-inch stainless-steel drain 3-1/2-inch crumb cup and tailpiece, Elkay model ELUHAD141455PD or equivalent.
- B. SK-1 Trim: ASME A112.18.1; ADA compliant chrome-plated supply with high rise swing spout, pull-down two-function sprayer and hose, maximum 1.8 gpm flow, ceramic valve cartridge, single lever handle, Delta model 9113DST or equivalent.
- C. SK-2 Trim: ASME A112.18.1; ADA compliant chrome-plated supply with 5 inch high rise swing spout, aerator, maximum 1.5 gpm flow, ceramic valve cartridge, single lever handle, Delta model 1903-DST or equivalent.
- D. SK-1 Accessories:
 - 1. Chrome-plated 17-gage brass P-trap and arm with escutcheon, metal ball valve stops (Brasscraft KT series), flexible supplies.
 - 2. For sinks, provide tempered water through regulating device conforming to ASSE 1070.
 - 3. Food waste disposer, stainless steel grind components, 1 hp, 120V/60Hz, 10.2A, Insinkerator model Badger 1HP or equivalent.
- E. SK-2 Accessories:
 - 1. Chrome-plated 17-gage brass P-trap and arm with escutcheon, metal ball valve stops (Brasscraft KT series), flexible supplies.
 - 2. For sinks, provide tempered water through regulating device conforming to ASSE 1070.

2.7 MS-1 SERVICE SINKS

- A. Bowl: 24 by 24 by 12 inches high Terrazzo, floor mounted, 45 degree angled front side, 1-3/4 inch wide shoulders, 3 inch pipe connection, stainless-steel wall caps and strainer, Florestone model 87 or equivalent.
- B. Trim: ASME A112.18.1 exposed wall type supply with lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges, Zurn model Z841M or equivalent.
- C. Accessories:
 - 1. 5 feet of 1/2 inch diameter plain end reinforced plastic hose.
 - 2. Hose clamp hanger.

3. Mop hanger.

2.8 SH-1 SHOWERS

A. Trim:

1. Valve: ASME A112.18.1 and ASSE 1016; ADA compliant cast brass concealed shower supply with combination pressure balanced and thermostatic mixing valves, adjustable high limit stop, integral service stops, single handle, escutcheon, polished chrome, Powers series e700 or equivalent.
2. Fixed head: Single function shower head, American Standard model 1660-710 or equivalent.
3. Hand shower: ADA compliant multi-function, 1.5 gpm, rubber nozzles, American Standard model 1660.766 or equivalent.
4. In-line vacuum breaker: American Standard model 1660-400 or equivalent.
5. Wall supply: Supply elbow, 1/2 inch, polished chrome, American Standard model 8888.037.002 or equivalent
6. Metal hose: 59 inch length metal hose, American Standard model 888.035 or equivalent.
7. 2-way diverter: ADA compliant 1/2 inch NPT brass body, polished chrome handle and escutcheon, American Standard model R422 and T342.430 or equivalent.
8. Slide-grab bar: ADA compliant 36 inch stainless steel bar with escutcheons and chrome plated hand shower holder, American Standard model 1662.236 or equivalent.

2.9 EWC-1 ELECTRIC WATER COOLERS

A. Fountain:

1. ARI 1010; ADA compliant dual height surface mounted electric water cooler and bottle filling station with stainless-steel top, stainless-steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push buttons on front and sides, electronic bottle filler sensor, water filter, mounting bracket, refrigerated with integral air cooled condenser.
2. Capacity: 8 gpm of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
3. Electrical: 115V/60Hz, 6 FLA, cord and plug for connection to electric wiring system.
4. Manufacturer and model: Elkay LZSTL8WSVRSK or equivalent.

B. Accessories:

1. P-trap and arm with escutcheon.
2. Metal ball valve stop, Brasscraft KT series
3. Flexible supply.

2.10 LAVATORY INSULATION KIT

- ### A. Product Description:
- Where Lavatories are noted to be insulated for ADA compliance, furnish the following: Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white or gray color, for insulating

tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify walls and floor finishes are prepared and ready for installation of fixtures.
- C. Verify electric power is available and of correct characteristics.
- D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.2 PREPARATION

- A. Rough-in fixture piping connections according to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install Work according to codes adopted by the authority having jurisdiction.
- B. Install each fixture with trap, easily removable for servicing and cleaning.
- C. Provide stainless steel braid-covered flexible supplies to fixtures with stops, reducers, and escutcheons.
- D. Install components level and plumb.
- E. Install and secure fixtures in place with wall supports or carriers and bolts.
- F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 079000, color to match fixture.
- G. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.
- H. For ADA accessible water closets, install flush valve with handle to wide side of stall.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.5 ADJUSTING

- A. Section 017000 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Final cleaning.
- B. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 017000 - Execution and Closeout Requirements: Protecting installed construction.
- B. Do not permit use of fixtures before final acceptance.

3.8 SCHEDULES

- A. Fixture Mounting Heights:
 - 1. Water Closet:
 - a. Standard: 15 inches to top of bowl rim.
 - b. Accessible: 18 inches to top of seat.
 - 2. Water Closet Flush Valves:
 - a. Standard: 11 inches min. above bowl rim.
 - 3. Urinal:
 - a. Accessible: 17 inches to top of bowl rim.
 - 4. Lavatory:
 - a. Accessible: 34 inches to top of basin rim.
 - 5. Drinking Fountain:
 - a. Standard Adult: 40 inches to top of basin rim.
 - b. Accessible: 36 inches to top of spout.
 - 6. Shower Heads:
 - a. Adult Male: 69.5 inches to bottom of fixed head.

END OF SECTION 224000

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Flashing.
4. Equipment curbs.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Firestopping and accessories for HVAC Work.
9. Equipment bases and supports.

B. Related Requirements:

1. Section 031000 - Concrete Forming and Accessories: Placement of [inserts] [sleeves] in concrete forms as required by this Section.
2. Section 033000 - Cast-in-Place Concrete: Placement of concrete housekeeping pads as required by this Section.
3. Section 099000 - Painting and Coating: Painting as required by this Section.
4. Section 220700 - Plumbing Insulation: Piping and accessory insulation as required by this Section.

1.2 REFERENCE STANDARDS

A. American Welding Society:

1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

B. ASME International:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
3. ASME B31.9 - Building Services Piping.

C. ASTM International:

1. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. FM Global:

1. FM - Approval Guide.

E. Intertek Testing Services (Warnock Hersey Mark):

1. WH-ETL - Product Directory.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.3 PREINSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 1. Hangers and Supports: Submit manufacturer's catalog information, including load capacity.
- C. Shop Drawings:
 1. Indicate system layout with location, including critical dimensions and sizes.
 2. Indicate pipe hanger and support locations, and detail of trapeze hangers.
- D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 QUALITY ASSURANCE

- A. Welding of Hanger and Support Attachments to Building Structure: Comply with applicable authority and AWS D1.1/D1.1M.
- B. Perform Work according to codes and standards adopted by the authority having jurisdiction.
- C. Maintain one copy of each standard affecting Work of this Section on Site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

- C. Welders: AWS qualified within previous 12 months for employed weld types.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- 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. Provide additional protection according to manufacturer instructions.

1.8 AMBIENT CONDITIONS

- A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Minimum Conditions:
 - 1. Do not apply firestopping materials if temperature of substrate material and ambient air is below 60 degrees F.
 - 2. Maintain this minimum temperature before, during, and for minimum three days after installation of firestopping materials.
- C. Provide ventilation in areas to receive solvent cured materials.

1.9 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Refrigerant Piping:

1. Conform to ASME B31.5, ASTM F708, and MSS SP-58.
2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron or carbon steel, adjustable swivel, split ring.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Vertical Support: Steel riser clamp.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Copper-plated carbon-steel ring.

B. Accessories:

1. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuously threaded.

2.2 FLASHING

A. Metal Flashing:

1. Material: Galvanized steel.
2. Thickness: 26 gage.

B. Metal Counterflashing:

1. Material: Galvanized steel.
2. Thickness: 22 gage.

C. Sheet Lead Flashing:

1. Waterproofing: 5 psf.
2. Soundproofing: 1 psf.

D. Flexible Flashing:

1. Material:
 - a. Sheet butyl.
 - b. Compatible with roofing.
2. Thickness: 47 mils.

E. Caps:

1. Material: Steel.
2. Minimum Thickness:

- a. 22 gage.
- b. 16 gage at fire-resistive elements.

2.3 EQUIPMENT CURBS

A. Description:

- 1. Shell and Base: Welded 18-gage galvanized steel.
- 2. Cant: Mitered; 3 inches.
- 3. Insulation Thickness: 1-1/2 inches.
- 4. Wood Nailer: Factory installed.

2.4 SLEEVES

A. Pipes through Non-fire-rated Floors:

- 1. Material: Galvanized steel.
- 2. Thickness: 18 gage.

B. Pipes through Non-fire-rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-gage galvanized steel.

C. Round Ductwork: Galvanized steel.

D. Rectangular Ductwork: Galvanized steel.

E. Sealant:

- 1. As specified in Section 079000 - Joint Protection.
- 2. Material: Acrylic.

2.5 MECHANICAL SLEEVE SEALS

A. Description:

- 1. Type: Modular mechanical.
- 2. Configuration: Interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
- 3. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and insulation.

2.6 FORMED STEEL CHANNEL

A. Description:

- 1. Material: Galvanized 12-gage steel.
- 2. Thickness: 12 gage.
- 3. Hole Spacing: 1-1/2 inches o.c.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that openings are ready to receive sleeves.

3.2 PREPARATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- C. Do not drill or cut structural members.

3.3 INSTALLATION

A. Pipe Hangers and Supports:

- 1. Comply with ASME B31.1, B31.5, and B31.9 or ASTM F708 and MSS SP-58.
- 2. Support horizontal piping per applicable code and schedule at end of this section.
- 3. Minimum Hanger Spacing: 1/2 inch between finished covering and adjacent Work.
- 4. Place hangers within 12 inches of each horizontal elbow.
- 5. Minimum Vertical Hanger Adjustment: 1-1/2 inches.
- 6. Support vertical piping at every floor.
- 7. If piping is installed in parallel and at same elevation, provide multiple-pipe or trapeze hangers.
- 8. Support riser piping independently of connected horizontal piping.
- 9. Provide copper-plated hangers and supports for copper piping.
- 10. Design hangers for pipe movement without disengagement of supported pipe.
- 11. Painting and Coating:
 - a. Prime coat exposed steel hangers and supports as specified in Section 099000 - Painting and Coating.
 - b. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- 12. Insulation:
 - a. Provide clearance in hangers and from structure and other equipment for installation of insulation.
 - b. As specified in Section 230700 - HVAC Insulation.

B. Equipment Bases and Supports:

1. Provide housekeeping pads of concrete as specified in Section 033000 - Cast-in-Place Concrete.
2. Minimum Size: 3-1/2 inches thick and extending 6 inches beyond supported equipment.
3. Use templates furnished with equipment to install equipment anchor bolts and accessories.
4. Supports:
 - a. Material: Steel members, formed steel channel or steel pipe and fittings.
 - b. Brace and fasten with flanges bolted to structure.

C. Flashing:

1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
2. For sound control, provide acoustical-lead flashing around ducts and pipes penetrating equipment rooms.
3. Curbs:
 - a. Provide curbs for roof installations with minimum height of 14 inches above roofing surface.
 - b. Flash and counterflash with sheet metal and seal watertight.
 - c. Attach counterflashing to equipment and lap base flashing on roof curbs.
 - d. Flatten and solder joints.
4. Storm Collars:
 - a. Adjust storm collars tight to pipe with bolts and calk around top edge.
 - b. Install storm collars above roof jacks.

D. Sleeves:

1. Exterior Watertight Entries: Seal with mechanical sleeve seals.
2. Set sleeves in position in forms and provide reinforcing around sleeves.
3. Sizing:
 - a. Size sleeves large enough to allow for movement due to expansion and contraction.
 - b. Provide for continuous insulation wrapping.
4. Extend sleeves through floors 1 inch above finished floor level, and calk sleeves.
5. Spaces:
 - a. If piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent Work with stuffing insulation and calk.
 - b. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
 - c. Install chrome-plated steel or stainless-steel escutcheons at finished surfaces.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

- B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

3.5 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.

3.6 PROTECTION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.7 ATTACHMENTS

- A. Pipe Hanger Spacing:
 - 1. Pipe Material: Copper tube.
 - a. Size: 1-1/4 inches and smaller.
 - b. Maximum Hanger Spacing: 6 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 - 2. Pipe Material: Copper tube.
 - a. Size: 1-1/2 inches and larger.
 - b. Maximum Hanger Spacing: 10 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 - 3. Pipe Material: PVC.
 - a. Maximum Hanger Spacing: 4 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
 - 4. Pipe Material: Steel.
 - a. Size: 3 inches and smaller.
 - b. Maximum Hanger Spacing: 12 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 - 5. Pipe Material: Steel.
 - a. Size: 4 inches and larger.
 - b. Maximum Hanger Spacing: 12 feet.
 - c. Hanger Rod Diameter: 5/8 inch.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.

B. Related Sections:

1. Section 099000 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Nameplates
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Plastic Tags
 - a. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
- B. Metal Tags
 - a. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- C. Information Tags
 - a. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:

1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
4. Ductwork and Equipment: 1-3/4 inches high letters.

- B. Stencil Paint: As specified in Section 099000, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.

- B. Plastic Pipe Markers

1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

- C. Plastic Tape Pipe Markers

1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.5 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color-coded head.

- B. Color code as follows:

1. HVAC equipment: Yellow.
2. Fire dampers/smoke dampers: Red.
3. Plumbing valves: Green.
4. Heating/cooling valves: Blue.

2.6 LABELS

- A. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification.

2.7 UNDERGROUND WARNING TAPE

- A. Description: Polyethylene tape with metallic core for detection and location of piping with metal detector resistant to acids, alkalis and other soil components.

1. Size: 0.004 inch thick; 6 inches wide.
2. Color: As selected.
3. Service Marking: Printed text as selected by Architect/Engineer in black color and repeated at maximum 40 inches intervals.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 099000 for stencil painting.

3.2 INSTALLATION

- A. Apply stencil painting in accordance with Section 099000.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain. Number tags consecutively by location.
- F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
- H. Identify control panels and major control components outside panels with plastic nameplates.
- I. Identify valves in main and branch piping with tags.
- J. Identify air terminal units and radiator valves with numbered tags.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.
- L. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- M. For exposed natural gas lines other than steel pipe, attach yellow pipe labels with "GAS" in black lettering, at maximum 5 foot spacing.
- N. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- O. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 230553

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing adjusting, and balancing of air systems.
2. Measurement of final operating condition of HVAC systems.

B. Related Sections:

1. Section 230993 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. Testing Adjusting and Balancing Bureau:

1. TABB - International Standards for Environmental Systems Balance.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms, forms prepared following ASHRAE 111, NEBB Report forms, or TABB Report Forms.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

- E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty, Copy of NEBB Certificate of Conformance Certification, or TABB International Quality Assurance program guarantee.
- F. Submit draft copies of report for review prior to final acceptance of Project.
- G. Furnish reports in binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with codes adopted by the authority having jurisdiction.
- B. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems, or TABB International Quality Assurance program.
- C. Maintain one copy of each document on site.
- D. Prior to commencing Work, calibrate each instrument to be used.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC, Certified by NEBB, or Certified by TABB.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

- A. Section 011000 - Summary: Work sequence.

- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.

PART 2 - PRODUCTS

- 2.1 Not Used.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. HVAC control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.

3.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus 10 or minus 0 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 0 percent of design to space. Adjust outlets and inlets in space to within plus 10 or minus 0 percent of design.

3.4 ADJUSTING

- A. Section 017000 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities at site altitude.
- B. Measure air quantities at air inlets and outlets.
- C. Adjust distribution system to obtain:
 - 1. Minimal objectionable drafts.
- D. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- E. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- F. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- J. At modulating damper locations, take measurements and balance at extreme conditions.

- K. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches differential static pressure near building entries.

3.6 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Air Cooled Refrigerant Condensers.
 - 2. Packaged Roof Top Heating/Cooling Units.
 - 3. Fan Coil Units.
 - 4. Makeup Air Units.
 - 5. Fans.
 - 6. Air Inlets and Outlets.
 - 7. Heat Pump Outdoor Units.
- B. Report Forms
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
 - 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 - 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
 - 4. Electric Motors:

- a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
5. V-Belt Drive:
- a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
6. Air Cooled Condenser:
- a. Identification/number
 - b. Location
 - c. Manufacturer
 - d. Model number
 - e. Serial number
 - f. Entering DB air temperature, design and actual
 - g. Leaving DB air temperature, design and actual
 - h. Number of compressors
7. Cooling Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Saturated suction temperature, design and actual
 - k. Air pressure drop, design and actual
8. Heating Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air temperature, design and actual

- g. Leaving air temperature, design and actual
 - h. Air pressure drop, design and actual
9. Fan Coil Data:
- a. Manufacturer
 - b. Identification/number
 - c. Location
 - d. Model number
 - e. Size
 - f. Air flow, design and actual
 - g. Entering air temperature, design and actual
 - h. Leaving air temperature, design and actual
10. Makeup Air Units:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
 - o. Heating entering air temperature
 - p. Heating leaving air temperature
 - q. Cooling entering air temperature
 - r. Cooling leaving air temperature
11. Return Air/Outside Air Data:
- a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio

12. Exhaust Fan Data:

- a. Location
- b. Manufacturer
- c. Model number
- d. Serial number
- e. Air flow, specified and actual
- f. Total static pressure (total external), specified and actual
- g. Inlet pressure
- h. Discharge pressure
- i. Sheave Make/Size/Bore
- j. Number of Belts/Make/Size
- k. Fan RPM

13. Air Distribution Test Sheet:

- a. Air terminal number
- b. Room number/location
- c. Terminal type
- d. Terminal size
- e. Area factor
- f. Design velocity
- g. Design air flow
- h. Test (final) velocity
- i. Test (final) air flow
- j. Percent of design air flow

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HVAC piping insulation, jackets and accessories.
2. HVAC ductwork insulation, jackets, and accessories.

B. Related Sections:

1. Section 099000 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.

1.2 REFERENCES

A. ASTM International:

1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
5. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
6. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
7. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
8. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
9. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
10. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
11. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
12. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
13. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
14. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
15. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

16. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
17. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
18. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
19. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
20. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
21. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
22. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
23. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
24. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

B. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. Underwriters Laboratories Inc.:

1. UL 1978 - Standard for Safety for Grease Ducts.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

1.4 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- D. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.
- E. Perform Work in accordance with codes adopted by the authority having jurisdiction.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

- A. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F.
 - 2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.2 PIPE INSULATION JACKETS

- A. Aluminum Pipe Jacket:
 - 1. ASTM B209.
 - 2. Thickness: minimum 0.016 inch thick sheet.
 - 3. Finish: Smooth or embossed.
 - 4. Joining: Longitudinal slip joints and 2 inch laps.
 - 5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.3 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Adhesives: Compatible with insulation.

2.4 DUCTWORK INSULATION

- A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
 - 1. Thermal Conductivity: 0.25 at 75 degrees F.
 - 2. Maximum Operating Temperature: 250 degrees F.
 - 3. Density: 1.5 pound per cubic foot.
- B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied all service facing meeting ASTM C1136, Type II.

1. Thermal Conductivity: 0.24 at 75 degrees F.
 2. Density: 2.25 pound per cubic foot.
- C. TYPE D-4: ASTM C1071, Type I, flexible, glass fiber duct liner with coated air side.
1. Thermal Conductivity: 0.24 at 75 degrees F.
 2. Density: 1.5 pound per cubic foot.
 3. Maximum Operating Temperature: 250 degrees F.
 4. Maximum Air Velocity: 6,000 feet per minute.
- D. TYPE D-8: Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978.
1. Thermal Conductivity: 0.42 at 500 degrees F.
 2. Weight: 1.4 pound per square foot.
 3. Surface Burning Characteristics: Maximum 0/0 flame spread/smoke developed index when tested in accordance with ASTM E84.

2.5 DUCTWORK INSULATION JACKETS

- A. Aluminum Duct Jacket:
1. ASTM B209.
 2. Thickness: 0.032 inch thick sheet.
 3. Finish: Smooth.
 4. Joining: Longitudinal slip joints and 2 inch laps.
 5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
- B. Vapor Retarder Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
 3. Secure with pressure sensitive tape.

2.6 DUCTWORK INSULATION ACCESSORIES

- A. Vapor Retarder Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- B. Vapor Retarder Lap Adhesive: Compatible with insulation.
- C. Adhesive: Waterproof, ASTM E162 fire-retardant type.
- D. Liner Fasteners: Galvanized steel, welded with integral or press-on head.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

- F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- H. Adhesives: Compatible with insulation.
- I. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 078400 for penetrations of assemblies with fire resistance rating greater than one hour.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
- D. Glass Fiber Board Insulation:
 - 1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
 - 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

F. Insulation Terminating Points:

1. Condensate Piping: Insulate entire piping system and components to prevent condensation.

G. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

H. Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

I. Prepare pipe insulation for finish painting. Refer to Section 099000.

3.3 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are sheet metal dimensions.

B. Insulated ductwork conveying air below ambient temperature:

1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. External Glass Fiber Duct Insulation:

1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.

5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

D. Duct Liner:

1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

E. Kitchen Exhaust Ductwork:

1. Comply with insulation manufacturer's installation instructions.
2. Cover duct by wrapping with insulation using overlap method.
3. Overlap seams of each method by 3 inches.
4. Attach insulation using steel banding or by welded pins and clips.
5. Install insulation without sag on underside of ductwork. Use additional fasteners to prevent sagging.

F. Ducts Exterior to Building:

1. Install insulation according to external duct insulation paragraph above.
2. Provide external insulation with vapor retarder jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
3. Finish with aluminum duct jacket.
4. Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.

- G. Prepare exposed duct insulation for finish painting. Refer to Section 099000.

3.4 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

1. Refrigerant Suction:
 - a. Type: P-5.
 - b. Thickness: 1.5 inch
2. Refrigerant Hot Gas:
 - a. Type: P-5.
 - b. Thickness: 1.0 inch

B. Ductwork Insulation Schedule:

1. RTU-1, RTU-2, RTU-3, FC-1, and FC-2 Rectangular Supply Ducts - Internally Insulated:

- a. Type: D-4.
 - b. Thickness: 1.0 inch
2. RTU-1, RTU-2, RTU-3 FC-1, and FC-2 Rectangular Return Ducts - Internally Insulated:
 - a. Type: D-4.
 - b. Thickness: 1.0 inch
3. MA-1, MA-2, and RTU-4 Rectangular and Round Supply Ducts - Externally Insulated, Installed Thickness:
 - a. Type: D-1 or D-2.
 - b. Thickness: 1.0 or 1.5 inches
4. MA-1, MA-2, and RTU-4 Rectangular and Round Return Ducts - Externally Insulated, Installed Thickness:
 - a. Type: D-1 or D-2.
 - b. Thickness: 1.0 or 1.5 inches
5. Outdoor Air Ducts to FC-1 and FC-2- Externally Insulated, Installed Thickness:
 - a. Type: D-1 or D-2.
 - b. Thickness: 1.0 or 1.5 inches
6. Round Supply Ducts - Externally Insulated, Installed Thickness:
 - a. Type: D-1 or D-2.
 - b. Thickness: 1.0 or 1.5 inches
7. Round Return Ducts - Externally Insulated, Installed Thickness:
 - a. Type: D-1 or D-2.
 - b. Thickness: 1.0 or 1.5 inches
8. Kitchen Exhaust:
 - a. Type: D-8.
 - b. Thickness: 3.0 inches or as required by manufacturer.
9. Supply and Return Air - Exterior to Building on Roof:
 - a. Type: D-2.
 - b. Thickness: 2.0 inches
10. Exhaust Ducts Within 10 feet of Exterior Openings, Installed Thickness:
 - a. Type: D-1 or D-2.
 - b. Thickness: 1.0 or 1.5 inches
11. Transfer Air Ducts - Internally Insulated:

- a. Type: D-4.
- b. Thickness: 1.0 inches

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermostats.
- B. Related Requirements:
 - 1. Section 230553 - Identification for HVAC Piping and Equipment: Nameplates and labeling for control panels specified in this Section.
 - 2. Section 230993 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this Section.
 - 3. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections specified by this Section.

1.2 REFERENCE STANDARDS

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- C. American Society of Mechanical Engineers:
 - 1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ASTM International:
 - 1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. ASTM A536 - Standard Specification for Ductile Iron Castings.
 - 3. ASTM B32 - Standard Specification for Solder Metal.
 - 4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 - 5. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
 - 6. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 - 7. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.
- E. American Welding Society:
 - 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 - 2. AWS A5.8M - Specification for Filler Metals for Brazing and Braze Welding.

F. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats.

G. National Fire Protection Association:

1. NFPA 72 - National Fire Alarm and Signaling Code.
2. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.

1.3 COORDINATION

- A. Section 013000 - Administrative Requirements: Requirements for coordination.

1.4 PREINSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
1. Submit description and engineering data for each control system component, including sizing as applicable.

1.6 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Requirements for closeout procedures.
- B. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors.
- C. Operation and Maintenance Data: Submit inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

1.7 QUALITY ASSURANCE

- A. Perform Work according to codes adopted by the authority having jurisdiction.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept controls on-Site in original factory packaging and inspect for damage.
- C. Store materials according to manufacturer's instructions.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 THERMOSTATS

- A. Electric Room Thermostats for Unit Heaters:
 - 1. Comply with NEMA DC 3.
 - 2. Voltage: 24 V.
 - 3. Programmable, 7-day schedule.
 - 4. Furnish setback/setup temperature control.
 - 5. Service: Heating only, 1-stage.
 - 6. Setpoint lockout capability to prevent unauthorized setpoint adjustment.
- B. Line Voltage Thermostats:
 - 1. Dead Band: Maximum 2 degrees F.
 - 2. Cover: Locking with set point adjustment, without thermometer.
- C. Thermostat accessories: Provide hat-channel wall support to hold thermostat off of wall surface where indicated on Plan.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that air-handling units and ductwork installation has been completed and that air filters are in place before installing sensors in airstreams.
- C. Verify locations of thermostats and other exposed control sensors with Drawings before installation.
- D. Verify that building systems to be controlled are ready to operate.

3.2 INSTALLATION

- A. Thermostats:
 - 1. Install after locations have been coordinated with other work.
 - 2. Install 42 inches above floor.
 - 3. Align with light switches.
 - 4. Install on support holding thermostat 1 inch off of exterior walls and walk-in box walls.

3.3 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.
- B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. After completion of installation, test and adjust control equipment.
- D. Submit data showing set points and final adjustments of controls.
- E. Calibration:
 - 1. Check calibration of instruments.
 - 2. Recalibrate instruments out of calibration.
 - 3. Replace defective instruments.
- F. Equipment Acceptance:
 - 1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.

3.4 DEMONSTRATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate complete operation of systems, including sequence of operation, equipment startup, shutdown, routine maintenance, and emergency repair procedures, to Owner's personnel.

3.5 MAINTENANCE

- A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Provide service and maintenance of control system for one year from date of Substantial Completion.
- C. Furnish complete service of controls systems, including callbacks.
- D. Repair or replace parts according to manufacturer's operating and maintenance data, using parts produced by manufacturer of original equipment.
- E. Perform Work without removing units from service during normal building occupied hours.
- F. Provide emergency callback service during working hours for this maintenance period.
- G. Perform Work using personnel under supervision and in direct employ of manufacturer or original installer.
- H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

END OF SECTION 230900

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SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1.1 SUMMARY

- A. Section includes sequence of operation for:
 - 1. Packaged rooftop HVAC units.
 - 2. Multizone mini split systems.
 - 3. Condensing units.
 - 4. Supply fans.
 - 5. Exhaust fans.
 - 6. Circulation fans.
 - 7. Kitchen hoods.
 - 8. Makeup air units.
 - 9. Electric finned tube baseboard heaters.
 - 10. Unit heaters.
- B. Related Sections:
 - 1. Section 230900 - Instrumentation and Control for HVAC: For equipment, devices, and system components to implement sequences of operation.
 - 2. Section 230953 - Pneumatic and Electric Control System for HVAC: For equipment, devices, and system components to implement sequences of operation.

1.2 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
 - 2. Submit flow diagrams for each control system, graphically depicting control logic.
 - 3. Coordinate submittals with information requested in Section 230900.

1.3 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION

3.1 PACKAGED ROOFTOP HVAC UNITS RTU-1, RTU-2, RTU-3, AND RTU-4

A. Occupied Mode:

1. During occupied periods, the supply fan shall run continuously and the outside air damper shall open to maintain minimum ventilation requirements. The DX cooling and gas heat shall stage to maintain the occupied space temperature setpoint. If economizing is enabled the outside air damper shall modulate to maintain the occupied space temperature setpoint.

B. Unoccupied Mode:

1. When the space temperature is below the unoccupied heating setpoint of 55.0 deg. F (adj.) the supply fan shall start, the outside air damper shall remain closed and the gas heat shall be enabled. When the space temperature rises above the unoccupied heating setpoint of 55.0 deg. F (adj.) plus the unoccupied differential of 4.0 deg. F (adj.) the supply fan shall stop and the gas heat shall be disabled.
2. When the space temperature is above the unoccupied cooling setpoint of 85.0 deg. F (adj.) the supply fan shall start, the outside air damper shall open if economizing is enabled and remain closed if economizing is disabled and the DX cooling shall be enabled. When the space temperature falls below the unoccupied cooling setpoint of 85.0 deg. F (adj.) minus the unoccupied differential of 4.0 deg. F (adj.) the supply fan shall stop, the DX cooling shall be disabled and the outside air damper shall close.

C. Optimal Start:

1. The unit controller shall monitor the scheduled occupied time, occupied space setpoints and space temperature to calculate when the optimal start occurs.

E. Morning Warm-Up Mode:

1. During optimal start, if the space temperature is below the occupied heating setpoint a morning warm-up mode shall be activated. When morning warm-up is initiated, the unit shall enable the heating and supply fan. The outside air damper shall remain closed. When the space temperature reaches the occupied heating setpoint (adj.), the unit shall transition to the occupied mode temperature setpoints. Occupied mode ventilation shall not be enabled until the scheduled occupancy time or upon enabling of occupancy bypass.

F. Pre-Cool Mode:

1. During optimal start, if the space temperature is above the occupied cooling setpoint, pre-cool mode shall be activated. When pre-cool is initiated, the unit shall enable the fan and cooling or economizer. The outside air damper shall remain closed, unless economizing. When the space temperature reaches occupied cooling setpoint (adj.), the unit shall transition to the occupied mode temperature setpoints. Occupied mode ventilation shall

not be enabled until the scheduled occupancy time or upon enabling of occupancy bypass.

G. Optimal Stop:

1. The unit controller shall monitor the scheduled unoccupied time, occupied setpoints and space temperature to calculate when the optimal stop occurs. When the optimal stop mode is active the unit controller shall maintain the space temperature to the space temperature offset setpoint.

H. Occupied Bypass:

1. The unit controller shall monitor the status of the “on” and “cancel” buttons of the space temperature sensor. When an occupied bypass request is received from a space sensor, the unit shall transition from its current occupancy mode to occupied bypass mode and the unit shall provide ventilation and maintain the space temperature to the occupied setpoints (adj.) for two hours.

I. Cooling Mode:

1. The unit controller shall monitor space temperature and space temperature cooling setpoint to determine when to initiate requests for cooling. When the space temperature rises above the space temperature cooling setpoint, the unit controller shall modulate the economizer or stage the mechanical cooling On or Off as required to maintain the space temperature cooling setpoint. The first compressor shall energize after its minimum 3-minute off time has expired. The supply fan shall operate at the necessary speed to provide full design air flow. If additional cooling capacity is required the next stage of cooling shall be enabled. Once the space temperature falls below the setpoint the compressors shall be deactivated and the fan speed shall not change.

J. Heating Mode:

1. The unit controller shall monitor space temperature and space temperature heating setpoint to determine when to initiate requests for heat. When the space temperature drops below the space temperature heating setpoint, the controller shall enable the first stage of heat. If additional heating capacity is required the second stage of heat shall be enabled. The supply fan shall operate at the necessary speed to provide full design air flow. Once the space temperature rises above the setpoint, the heating stages shall be disabled and the supply fan speed shall not change.

K. Economizer Control / Reference Dry Bulb:

1. The supply air sensor shall measure the dry bulb temperature of the air leaving the evaporator coil while economizing. When economizing is enabled and the unit is operating in the cooling mode, the economizer damper shall modulate between its minimum position and 100% to maintain the space temperature setpoint. Minimum position shall be set by the Test, Adjust, and Balance Contractor. If the supply air temperature starts to fall below supply air temperature setpoint, the outdoor damper shall be at minimum position. Compressors shall be delayed from operating until the economizer has opened to 100% for 5 minutes.

L. Reference Dry Bulb:

1. Outside air temperature shall be compared with a reference dry bulb setpoint of 75°F. The economizer shall enable when the outdoor air temperature is less than or equal to reference dry bulb setpoint. The economizer shall be controlled as required by the 2015 IECC.

- M. Demand Control Ventilation (DCV):
 - 1. DCV shall not be provided for the constant volume RTUs.
- N. Supply Fan Operation:
 - 1. The supply fan shall be enabled while in the occupied mode and cycled on during the unoccupied mode. The supply fan shall operate at the same constant speed for all modes. A differential pressure switch shall monitor the differential pressure across the fan. If the switch does not open within 40 seconds after a request for fan operation, a fan failure alarm shall be annunciated, the unit shall stop, requiring a manual reset.
- O. Building Pressure Control:
 - 1. The barometric (gravity operated) relief dampers shall open with increased building pressure. As the building pressure increases, the pressure in the unit return section also increases, opening the dampers and relieving air. The powered exhaust shall be enabled when the outdoor air damper actuator auxiliary switch closes and shall be set by the Test, Adjust, and Balance Contractor to prevent excess building static pressure.
- P. Filter Status:
 - 1. A differential pressure switch shall monitor the differential pressure across the filter when the fan is running. If the switch closes for 2 minutes after a request for fan operation a dirty filter alarm shall be annunciated at the wall-mounted temperature control.

3.2 VRF MULTIZONE MINI SPLIT SYSTEMS HP-1 WITH FC-1 AND FC-2

- A. The VRF multizone mini split systems shall consist of two indoor fan coils and an outdoor heat pump with inverter driven compressor. Each fan coil shall include a wired wall-mounted controller for temperature control, programming of occupied/unoccupied modes for day of the week and time of day, and communication with the fan coil.
- B. Each fan coil shall be capable of operation in the same mode (heating or cooling) as the other fan coil or neither mode. It will not be possible to simultaneously provide heating at one fan coil and cooling at the other. The wall-mounted controller shall request heating or cooling when needed, and the heat pump shall shift from one mode to the other automatically as needed.
- C. During occupied mode operation, the supply fan at each fan coil shall operate continuously at constant speed.

3.3 CONDENSING UNIT CU-1

- A. CU-1 shall include two scroll compressors, one of which is a digital scroll compressor. CU-1 shall provide cooling capacity modulation to the two-circuit DX coil at makeup air unit MA-2 by on/off control of the non-digital compressor combined with modulation of the scroll compressor capacity.
- B. CU-1 shall be controlled by the factory-installed controls at CU-1, the factory-installed controls at MA-2, and the programmable space thermostat. When MA-2 and the space thermostat call for cooling from CU-1, the CU-1 control system shall stage and modulate the compressors to hold the discharge air temperature, as sensed by the discharge air temperature sensor located in the supply duct 20 ft. from MA-2, at one of two setpoints. First stage cooling called for by the

thermostat shall engage LOW COOL discharge air temperature setpoint of 62°F (adjustable). Second stage cooling called for by the thermostat shall engage HIGH COOL discharge air temperature setpoint of 57°F (adjustable).

3.4 SUPPLY FAN SYSTEMS SF-1

- A. SF-1 shall be controlled by the programmable lighting controller on the occupancy schedule for the area served. During occupancy, SF-1 shall run continuously. A freeze-stat shall be installed in the supply air duct of fan coil FC-2 and shall disable SF-1 in the event of air temperature below 40°F.

3.5 EXHAUST FANS EF-1, EF-5, EF-6, EF-7, AND EF-8

- A. Exhaust fans EF-1, EF-5, EF-6, EF-7, and EF-8 shall be controlled by the programmable lighting controller to run during the programmed occupancy times for the building. Each fan shall be separately controlled so that each program may be unique.

3.6 EXHAUST FANS EF-2 AND EF-3

- A. Exhaust fan EF-2 serving hood KH-1 and EF-3 serving hood KH-2 shall be controlled by a 0-10Vdc modulating control output for each fan at the hood controller. EF-2 and EF-3 shall include electronically commutated motors utilizing the 0-10Vdc control signal for speed control.
- B. Refer to the hood controls for the control sequences.

3.7 EXHAUST FAN EF-4

- A. EF-4, serving the ware washer and moving the minimum required flow rate of ventilation air when EF-2 and EF-3 are not in operation, shall run whenever the HVAC system is in occupied mode as programmed at the space thermostat. If the HVAC system is not in occupied mode when the ware washer is to operate, the user shall engage occupied mode override at the thermostat to force EF-4 to run.

3.8 CIRCULATION FANS CF-1 AND CF-2

- A. Each circulation fan shall be controlled by a wall-mounted line voltage thermostat that closes contacts on a rise in temperature. The setpoint shall be 80°F.

3.9 KITCHEN HOODS KH-1 AND KH-2

- A. The two kitchen hoods shall include a control panel provided by the hood manufacturer to control the hood lights and the associated HVAC equipment.
- B. Refer to the hood controls for the control sequences.

3.10 MAKEUP AIR UNIT MA-1

- A. MA-1 serves the ventilation needs of the warehouse areas by delivering outdoor air that has been heated to near room temperature during the heating season and evaporatively cooled during the cooling season. MA-1 consists of an evaporative cooler, supply fan, modulating indirect fired gas heating section, motorized outdoor air damper, discharge air temperature sensor, outdoor air temperature sensor, and freezestat with manual reset.
- B. MA-1 shall be controlled by the programmable lighting controller to run during the programmed occupancy times for the building. When MA-1 is to run, the blower shall run continuously.
- C. Heating: When the outdoor temperature is below 60°F, heat shall be modulated to maintain the discharge temperature at 70°F. If the discharge air temperature falls to 45°F, the freezestat shall shut down and lockout MA-1
- D. Cooling: When the outdoor temperature is above 75°F, the evaporative cooler shall operate. When the outdoor air temperature falls to 40°F, the evaporative cooler sump shall be automatically drained and shall not refill until the outdoor temperature reaches 70°F.

3.11 MAKEUP AIR UNIT MA-2

- A. MA-2 consists of a mixing box for ventilation and OA economizer (modulating OA and RA dampers), DX cooling coil with two refrigerant circuits, modulating and 2-stage gas-fired duct furnaces, supply fan, 7-day programmable 2-stage cooling and 2-stage heating thermostat with occupied/unoccupied mode control and mode override, freezestat, and necessary controls.
- B. MA-2 serves the HVAC needs of the kitchen:
 - 1. Heating by modulating gas-fired duct furnace
 - 2. Cooling by DX coil and remote condensing unit CU-1. Refer to control sequence for CU-1.
 - 3. Occupied mode ventilation when hood fans EF-1 and EF-2 are not running
 - 4. Ventilation and makeup air when hood fans EF-1 and EF-2 are running
 - 5. Unoccupied mode heating and cooling
- C. When the thermostat is in unoccupied mode, all exhaust fans shall be off unless they are run by the control system for KH-1 and KH-2, MA-2 OA damper shall be fully closed and RA damper fully open, cooling shall not be provided, and MA-2 supply fan and heating shall cycle as required to maintain the unoccupied heating temperature setpoint of 55°F.
- D. When the thermostat is in occupied mode
 - 1. When fans EF-2 and EF-3 are not running:
 - a. Fan EF-4 for the warewasher shall run.
 - b. MA-2 supply fan shall run unless the freezestat contacts open or the controls for hoods KH-1 and KH-2 open a contact to shut down MA-2.
 - c. OA and RA dampers shall provide OA equal to the EF-4 flow rate, unless cooling by OA economizer.
 - d. If heating is required, heat shall be modulated to maintain the room temperature at 68°F.
 - e. If cooling is required:

- 1) If the outdoor air temperature is below 70°F, the first stage of cooling shall be OA economizer modulated to maintain supply air temperature of 60°F. If economizer cooling is insufficient, the refrigerated cooling shall operate as the second stage of cooling. Fans EF-2 and EF-3 shall be staged and modulated to exhaust quantity of air provided by economizer cooling.
 - 2) If the outdoor air temperature is above 75°F, the OA and RA dampers shall provide OA equal to the EF-4 flow rate and cooling shall be by the refrigerated cooling.
2. When fans EF-2 and/or EF-3 are running:
- a. Speed of EF-2 and EF-3 shall be modulated by the control system provided with KH-1 and KH-2.
 - b. The OA and RA dampers shall modulate to provide the amount of makeup air required for EF-2, EF-3, and EF-4. Modulation shall be controlled by the analog output at the controls for KH-1 and KH-2.
 - c. If heating is required, heat shall be modulated to maintain the room temperature at 68°F. Thermostat first stage of heating shall cause the heating to modulate and stage to maintain 65°F (adjustable) discharge air temperature. Thermostat second stage of heating shall cause the heating to modulate and stage to maintain 75°F (adjustable) discharge air temperature
 - d. If cooling is required, CU-1 shall be enabled to run and capacity shall be modulated by the CU-1 factory installed discharge air temperature controls. Refer to control sequences for CU-1.
 - e. The controls for hoods KH-1 and KH-2 shall include a dry contact to shut down MA-2 in the event of fire.

3.12 ELECTRIC FINNED TUBE BASEBOARD HEATERS BB-1 AND BB-2

- A. Each electric baseboard heater shall be controlled by in integral line voltage thermostat set at 55°F.

3.13 UNIT HEATERS UH-1 THROUGH UH-11

- A. UH-1 through UH-11 shall be controlled by low voltage wall-mounted thermostats. When a thermostat calls for heat, the associated unit heater's factory installed controls shall perform burner firing and blower operation.

3.14 DOMESTIC HOT WATER CIRCULATION PUMP PC-1

- A. PC-1 shall be controlled by a 7-day programmable time clock provided by the Plumbing Contractor to run the pump during scheduled hours of building occupancy.

END OF SECTION 230993

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SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Natural gas piping above grade.
2. Unions and flanges.
3. Valves.
4. Pipe hangers and supports.
5. Strainers.
6. Natural gas pressure regulators.

B. Related Sections:

1. Section 099000 - Painting and Coating: Product requirements for painting for placement by this section.
2. Section 230529 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports for placement by this section.
3. Section 230553 - Identification for HVAC Piping and Equipment: Product requirements for valve and pipe identification for placement by this section.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
3. ASME B31.9 - Building Services Piping.
4. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
4. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

F. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.

G. Underwriters Laboratories Inc.:

1. UL 842 - Valves for Flammable Fluids.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- D. Use ball, valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 3. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - a. Strainers.
 - b. Natural gas pressure regulators.
- C. Test Reports: Indicate results of piping system pressure test.

- D. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, piping system, and system components.
- C. Operation and Maintenance Data: Submit for gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

1.6 QUALITY ASSURANCE

- A. Perform natural gas Work in accordance with NFPA 54.
- B. Perform work in accordance with applicable code and local gas company requirements.
- C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- D. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 COORDINATION

- A. Section 013000 - Administrative Requirements: Requirements for coordination.

1.13 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.2 REGULATOR VENT PIPING, ABOVE GRADE

- A. Indoors: Same as natural gas piping, above grade.
- B. Outdoors: PVC pipe, tubing, and fittings, UL 651.

2.3 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
 - 2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.

2. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.4 BALL VALVES

- A. BA-10 1/4 inch to 1 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, full port.
- B. BA-11 1-1/4 inch to 3 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, conventional port.

2.5 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 54, ASME 31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm): Malleable iron or carbon steel, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2 inches (and Larger: Carbon steel, adjustable, clevis.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Vertical Support: Steel riser clamp.
- F. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.6 STRAINERS

- A. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- B. 2-1/2 inches to 4 inches: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- C. 5 inches and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.7 NATURAL GAS PRESSURE REGULATORS

- A. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
 1. Comply with ANSI Z21.80.
 2. Temperatures: minus 20 degrees F to 150 degrees F.
 3. Body: Cast iron, steel, or aluminum.

4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
5. Disk, diaphragm, and O-ring: Nitrile.
6. Maximum inlet pressure: 150 psig.
7. Furnish sizes 2 inches and smaller with threaded ends.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Where required, bend pipe with pipe bending tools in accordance with procedures intended for that purpose.
- E. Install piping to conserve building space and not interfere with use of space.
- F. Size and install gas piping to provide sufficient gas to supply maximum appliance demand at pressure higher than appliance minimum inlet pressure.
- G. Group piping whenever practical at common elevations.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Sleeve pipe passing through partitions, walls and floors. Refer to Section 230529.
- J. Provide clearance for access to valves and fittings.
- K. Provide access where valves and fittings are not exposed.
- L. Provide support for utility meters in accordance with requirements of utility company.

- M. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood. Protect vent against entry of insects and foreign material.
 - 1. Minimum Vent Size: Connection size at regulator vent connection.
 - 2. Run individual vent line from each relief device, independent of breather vents.
- N. Breather vents may be manifolded together with piping sized for combined appliance vent requirements.
- O. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 099000.
- P. Install identification on piping systems. Refer to Section 230553.
- Q. Install valves with stems upright or horizontal, not inverted.
- R. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- S. Install medium pressure gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.
- T. Install medium pressure gas pressure regulator with tee fitting not less than 10 pipe diameters down stream of regulator. Cap or plug one opening of tee fitting.
- U. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.
- V. Provide new gas service. Gas service distribution piping to have initial minimum pressure of 2 psi.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements and 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Where gas appliance will be damaged by test pressure, disconnect appliance and cap piping during pressure test. Reconnect appliance after pressure test and leak test connection.
- C. Where gas appliance is designed for operating pressures equal to or greater than piping test pressure, provide gas valve to isolate appliance or equipment from gas test pressure.
- D. Pressure test natural gas piping in accordance with NFPA 54.
- E. Inspect, test and purge gas piping in accordance with applicable code and local gas company requirements.
- F. When pressure tests do not meet specified requirements, remove defective work, replace and retest.
- G. Immediately after gas is applied to a new system, or a system has been restored after gas service interruption, check pipe for leakage.

1. Where leakage is detected, shut off gas supply until necessary repairs are complete.
- H. Do not place appliances in service until leak testing and repairs are complete.

3.5 SCHEDULES

A. Steel Pipe Hanger Spacing:

1. Pipe Size 1/2 Inch:
 - a. Maximum Hanger Spacing: 6 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
2. Pipe Size 3/4 Inch:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
3. Pipe Size 1 Inch:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
4. Pipe Size 1-1/4 Inches:
 - a. Maximum Hanger Spacing: 7 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
5. Pipe Size 1-1/2 Inches:
 - a. Maximum Hanger Spacing: 9 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
6. Pipe Size 2 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 3/8 inch.
7. Pipe Size 2-1/2 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 1/2 inch.
8. Pipe Size 3 Inches:
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 1/2 inch.

END OF SECTION 231123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigerant piping.
2. Unions, flanges, and couplings.
3. Pipe hangers and supports.
4. Refrigerant moisture and liquid indicators.
5. Valves.
6. Refrigerant strainers.
7. Refrigerant pressure regulators.
8. Refrigerant pressure relief valves.
9. Refrigerant filter-driers.
10. Refrigerant solenoid valves.
11. Refrigerant expansion valves.
12. Electronic expansion valves.
13. Refrigerant receivers.
14. Underground pipe markers.
15. Bedding and cover materials.

B. Related Sections:

1. Section 230529 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, for placement by this section.
2. Section 230553 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
3. Section 230700 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
4. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 710 - Liquid-Line Driers.
2. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
3. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. American Society of Mechanical Engineers:

1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B31.5 - Refrigeration Piping.
4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. [ASTM B88M - Standard Specification for Seamless Copper Water Tube \(Metric\)](#).
5. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
7. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.

E. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:

1. UL 429 - Electrically Operated Valves.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide pipe hangers and supports in accordance with ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- C. Flexible Connectors: Use at or near condensing unit.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.

- B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- C. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Valves: Submit manufacturer's catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturer's catalog information including load capacity.
 - 4. Refrigerant Specialties: Submit manufacturer's catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
 - a. Refrigerant moisture and liquid indicators.
 - b. Refrigerant filter-driers.
 - c. Refrigerant solenoid valves.
- D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of refrigerant leak test and piping system pressure test.
- F. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- G. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.
- C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.
- B. Perform Work in accordance with codes adopted by authority having jurisdiction.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years' documented experience.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Dehydrate and charge refrigeration components including piping, seal prior to shipment. Maintain seal until connected into system.
- C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 COORDINATION

- A. Section 013000 - Administrative Requirements: Requirements for coordination.

1.13 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

1.14 MAINTENANCE MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

1.15 EXTRA MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two refrigerant filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, drawn.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 UNIONS, FLANGES, AND COUPLINGS

- A. 2 inches and Smaller:
 - 1. Copper Pipe: Bronze, soldered joints.

2.3 PIPE HANGERS AND SUPPORTS

- A. Refer to Section 230529.

2.4 REFRIGERANT MOISTURE AND LIQUID INDICATORS

- A. Indicators:
 - 1. Port: Single or double, UL listed.
 - 2. Body: Copper or brass, flared or solder ends.
 - 3. Sight glass: Color-coded paper moisture indicator with removable element cartridge and plastic cap.
 - 4. Maximum working pressure: 500 psig
 - 5. Maximum working temperature: 200 degrees F.

2.5 VALVES

- A. Ball Valves:
 - 1. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals, soldered ends.
 - 2. Maximum working pressure: 500 psig.
 - 3. Maximum working temperature: 300 degrees F.

2.6 REFRIGERANT FILTER-DRIERS

A. Replaceable Cartridge Angle Type:

1. Shell: ARI 710, UL listed, brass or steel, removable cap, for maximum working pressure of 500 psig, inches outside diameter size connections.
2. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina, AHRI 710 rating for system capacity.

2.7 REFRIGERANT SOLENOID VALVES

- A. Valve: AHRI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem designed to allow manual operation in case of coil failure.
- B. Coil Assembly: UL listed, suitable for outdoor installation, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box.
- C. Electrical Characteristics: As required to work with MA-2.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.5, ASTM F708, and MSS SP 89.
- B. Support horizontal piping hangers as scheduled.

- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Provide copper plated hangers and supports for copper piping.
- I. Prime coat exposed steel hangers and supports in accordance with Section 099000. Finish paint exposed steel hangers and supports in accordance with Section 099000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Route piping parallel to building structure and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 230529.
- E. Install pipe identification in accordance with Section 230553.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide access where valves and fittings are not exposed.
- H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- I. Flood refrigerant piping system with nitrogen when brazing.
- J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 099000.
- K. Install valves with stems upright or horizontal, not inverted.
- L. Insulate piping; refer to Section 230700.

- M. For CU-1, provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.
- N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- O. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- P. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- Q. Provide electrical connection to solenoid valves. Refer to Section 260503.
- R. Fully charge completed system with refrigerant after testing.
- S. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- T. Install refrigerant piping in accordance with ASME B31.5.

3.5 INSTALLATION - REFRIGERANT SPECIALTIES

- A. Refrigerant Liquid Indicators:
 - 1. Install line size liquid indicators in main liquid line downstream of condenser.
 - 2. Install line size liquid indicators downstream of liquid solenoid valves.
- B. Filter-Dryers:
 - 1. Install replaceable cartridge filter-dryer upstream of each solenoid valve.
- C. Solenoid Valves:
 - 1. Install in liquid line of systems operating with single pump-out or pump-down compressor control.
 - 2. Install in liquid line of single or multiple evaporator systems.

3.6 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements and 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test refrigeration system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using halide torch or electronic leak detector.
- D. Repair leaks.
- E. Retest until no leaks are detected.

END OF SECTION 232300

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SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Duct materials.
2. Glass-fiber ducts.
3. Flexible ducts.
4. Insulated flexible ducts.
5. Single-wall, spiral round ducts.
6. Transverse duct connection system.
7. Ductwork fabrication.
8. Glass-fiber ductwork fabrication.
9. Kitchen hood exhaust ductwork fabrication.
10. Duct cleaning.

B. Related Requirements:

1. Section 114000 - Foodservice Equipment: Requirements for kitchen range hoods for placement by this Section.
2. Section 233300 - Air Duct Accessories: Requirements for duct accessories as specified in this Section.

1.2 REFERENCE STANDARDS

A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE Handbook - Fundamentals.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.
2. AWS D1.2 - Structural Welding Code - Aluminum.
3. AWS D9.1 - Sheet Metal Welding Code.

C. ASTM International:

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A90 - Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
4. ASTM A568 - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
5. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

6. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
7. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
8. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

D. International Code Council:

1. International Energy Conservation Code (IECC).
2. International Mechanical Code (IMC).

E. NFPA:

1. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

F. Sheet Metal and Air Conditioning Contractors' National Association:

1. SMACNA 1767 - Kitchen Ventilation Systems and Food Service Equipment Guidelines.
2. SMACNA 1884 - Fibrous Glass Duct Construction Standards.
3. SMACNA 1966 - HVAC Duct Construction Standards - Metal and Flexible.

G. UL:

1. UL 181 - Factory-Made Air Ducts and Air Connectors.
2. UL 181A - Closure Systems for Use With Rigid Air Ducts.
3. UL 1978 - Grease Ducts.

1.3 PREINSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturer information for duct materials, duct liner, and duct connectors.
- C. Qualifications Statements:
 1. Submit qualifications for manufacturer, installer, and licensed professional.
 2. Submit manufacturer's approval of installer.

3. Welders: Qualify procedures and personnel according to AWS D1.1 for hangers and supports, AWS D1.2 for aluminum supports, and AWS D9.1 for duct joint and seam welding.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents:
 1. Record actual locations of ducts and duct fittings.
 2. Record changes in fitting location and type.
 3. Show additional fittings used.

1.6 QUALITY ASSURANCE

- A. Perform Work according to SMACNA 1884 and 1966.
- B. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.
- C. Perform Work according to SMACNA, ASHRAE, and NFPA standards.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.
- C. Welders: AWS qualified within previous 12 months for employed weld types.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- 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. Provide additional protection according to manufacturer instructions.

1.9 AMBIENT CONDITIONS

- A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Minimum Conditions: Do not install duct sealant when temperatures are less than those recommended by sealant manufacturer.
- C. Subsequent Conditions: Maintain temperatures during and after installation of duct sealant.

1.10 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 DUCTS

- A. Performance and Design Criteria:
 - 1. Variation of duct configuration or variation of sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission of Architect/Engineer.
 - 2. When approved, size round ducts installed in place of rectangular ducts according to ASHRAE Handbook - Fundamentals.
- B. Materials:
- C. Galvanized-Steel Ducts:
 - 1. Material: ASTM A653 galvanized-steel sheet.
 - 2. Quality: Lock forming.
 - 3. Finish: G90 zinc coating according to ASTM A90.
- D. Steel Ducts: Comply with ASTM A1008, A1011, and A568.
- E. Stainless-Steel Ducts: Comply with ASTM A666, Type 304 or 316.
- F. Fasteners: Rivets, bolts, or sheet metal screws.
- G. Hanger Rod:

1. Material: Galvanized steel.
2. Comply with ASTM A36.
3. Type: Threaded both ends or continuously.

2.2 GLASS-FIBER DUCTS

A. Description:

1. Rigid glass fiber with aluminum foil, glass scrim, and kraft or plastic jacket vapor barrier.
2. Comply with UL 181.
3. Thickness: 1 inch.
4. Maximum Thermal Conductivity: 0.23 Btu/sq. ft. x h x deg. F at 75 degrees F.

2.3 FLEXIBLE DUCTS

A. Description:

1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
2. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
3. Maximum Velocity: 4,000 fpm.
4. Temperature Range: Minus 20 to plus 210 degrees F.

2.4 INSULATED FLEXIBLE DUCTS

A. Description:

1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
2. Insulation: Fiberglass.
3. Vapor Barrier Film: PE Aluminized.
4. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
5. Maximum Velocity: 4,000 fpm.
6. Temperature Range: Minus 20 to plus 210 degrees F.
7. Thermal Resistance: 0.24 sq. ft. x h x deg. F/Btu.

B. Description:

1. UL 181, Class 0, interlocking spiral of aluminum foil.
2. Insulation: Fiberglass.
3. Vapor Barrier Film: PE Aluminized.
4. Pressure Rating: 8-inch wg positive or negative.
5. Maximum Velocity: 5,000 fpm.
6. Temperature Range: Minus 20 to plus 250 degrees F.
7. Thermal Resistance: 0.24 sq. ft. x h x deg. F/Btu.

2.5 SINGLE-WALL, SPIRAL ROUND DUCTS

A. Description:

1. UL 181, Class 1, round spiral lockseam duct.
2. Material: Galvanized steel.

B. Minimum Duct Wall Thicknesses:

1. Diameter 2 to 14 Inches: 26 gage.
2. Diameter 16 to 26 Inches: 24 gage.

C. Minimum Fittings Wall Thicknesses:

1. Diameter 2 to 14 Inches: 24 gage .
2. Diameter 16 to 26 Inches: 22 gage.

2.6 TRANSVERSE DUCT CONNECTION SYSTEM

A. Description:

1. Interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
2. Rigidity Class Connection: As appropriate for pressure and application.

2.7 FABRICATION

A. Rectangular Ducts:

1. According to SMACNA 1966.
2. Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.

B. Round Ducts:

1. According to SMACNA 1966.
2. Seams: Longitudinal.
3. Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.

C. Tees, Bends, and Elbows:

1. Minimum Radius:
 - a. 1-1/2 times centerline duct width.
 - b. If not possible or if rectangular elbows are used, provide airfoil turning vanes.
2. If acoustical lining is indicated, furnish turning vanes of perforated metal with glass-fiber insulation.

D. Divergence:

1. Increase duct sizes gradually, not exceeding 15 degrees of divergence wherever possible.
2. Upstream of Equipment: Maximum 30 degrees.
3. Downstream of Equipment: Maximum 30 degrees.

E. Welding:

1. Continuously Welded Round and Oval Duct Fittings: Two gages heavier than duct gages according to SMACNA 1966.

F. Takeoffs:

1. Provide standard 45-degree lateral wye takeoffs.
2. If not possible due to space limitations, provide 90-degree conical tee connections.

G. Sealing:

1. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
2. Sealants, Mastics, and Tapes: Comply with UL 181A and provide products bearing appropriate UL 181A markings.

H. Glass-Fiber Ducts:

1. Fabricate according to SMACNA 1884.
2. Tape: 3-inch-wide heat-activated chemical bonding tape.
3. Machine-fabricate glass-fiber ducts and fittings; only minor on-Site adjustments are permitted.
4. Staples for Duct Joints and Tape:
 - a. Material: Aluminum.
 - b. Size: 3 inches wide by 2 mils thick.
5. Glass-fiber duct shall only be used for sound attenuating elbows.

I. Kitchen Hood Exhaust Grease Ducts:

1. Comply with SMACNA 1767 and NFPA 96.
2. Concealed Kitchen Hood Exhaust Ducts:
 - a. Material: 16-gage carbon steel.
 - b. Joints: Continuous external weld.

J. Kitchen Hood Exhaust Grease Ducts: Factory-built commercial grease ducts labeled and listed according to UL 1978.

2.8 ACCESSORIES

A. Hangers and Supports:

1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

2. Strap and Rod Sizes:
 - a. Comply with SMACNA 1966.
 - b. Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884.
3. Trapeze and Riser Supports:
 - a. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - b. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - c. Supports for Aluminum Ducts: Aluminum or galvanized steel, coated with zinc chromate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify sizes of equipment connections before fabricating transitions.

3.2 PREPARATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Install temporary closures of metal or taped PE on open ductwork to prevent construction dust from entering ductwork system.

3.3 INSTALLATION

- A. Install and seal ducts according to SMACNA 1966.
- B. Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884.
- C. Insulated Flexible Duct Fittings:
 1. Join each flexible duct section to main trunk duct through sheet metal fittings.
 2. Material: Galvanized steel.
 3. Equip fittings with factory-installed volume damper having positive locking regulator.
 4. Provide insulation guard with fittings installed in lined ductwork.
- D. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inches and smaller.
- E. Hanger and Supports:
 1. Fabricate and support ducts according to SMACNA 1884 and 1966.

2. Threaded Rods: Provide double nuts and lock washers.
3. Building Attachments:
 - a. Provide structural-steel fasteners appropriate for construction materials to which hangers are being attached.
4. Hanger Spacing:
 - a. Comply with SMACNA 1884 and 1966.
 - b. Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
 - c. Extend strap supports down both sides of ducts and turn under bottom at least 1 inch.
 - d. Secure hanger to sides and bottom of ducts with sheet metal screws.
5. Hangers Exposed to View: Provide threaded rod and angle or channel supports.
6. Vertical Ducts:
 - a. Support with steel angles or channel secured to sides of duct with welds, bolts, sheet metal screws, or blind rivets.
 - b. Support at each floor and at maximum intervals of 16 feet.
7. Upper Attachments:
 - a. Attach to structures.
 - b. Selection and Sizing: Provide pull-out, tension, and shear capacities as required for supported loads and building materials.
8. Penetrations:
 - a. Avoid penetrations of ducts with hanger rods.
 - b. If unavoidable, provide airtight rubber grommets at penetrations.
- F. Connect flexible ducts to metal ducts with liquid adhesive and tape or draw bands.
- G. Kitchen Hoods:
 1. According to NFPA 96 and as specified in Section 114000 - Foodservice Equipment.
 2. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout.
- H. Outdoor Ductwork: Protect ductwork and ductwork supports, linings, and coverings from weather.
- I. Exhaust Outlet Locations:
 1. Minimum Distance from Property Lines: 3 feet.
 2. Minimum Distance from Building Openings: 3 feet.
 3. Minimum Distance from Outside Air Intakes: 10 feet.
- J. Interface with Other Work:

1. Connect diffusers to low-pressure ducts directly or with 3-foot maximum length of flexible duct held in place with strap or clamp.
2. Connect air outlets and inlets to supply ducts directly or with 3-foot maximum length of flexible duct; do not use flexible duct to change direction.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.
- B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Testing:
 1. Concealed Grease Ducts:
 - a. Prior to concealing, wrapping, or insulating grease ductwork, or placing grease duct in service, perform leakage test according to IMC in presence of authority having jurisdiction.
 - b. Perform light test by pulling minimum 100-W light through duct and observing for light leaks at duct joints.
 - c. Test complete extent of duct installed, including joint at which duct connects to exhaust hood.

3.5 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean duct system and force air at high velocity through duct to remove accumulated dust.
- C. To obtain sufficient airflow, clean one half of system completely before proceeding to other half.

***** OR *****

- D. Vacuuming:
 1. Clean duct systems with high-power vacuum machines.
 2. Install access openings into ductwork for cleaning purposes.
- E. Protect sensitive equipment with temporary filters or bypass during cleaning.

3.6 ATTACHMENTS

- A. Ductwork Material Schedule:
 1. Supply - Heating Systems: Steel.
 2. Supply - Systems with Cooling Coils: Steel.
 3. Return and Relief : Steel.

4. General Exhaust: Steel.
5. Kitchen Hood Exhaust: Steel or stainless steel.
6. Dishwasher Exhaust: Stainless steel.
7. Outside Air Intake: Steel.
8. Intake and Exhaust: Steel.

B. Ductwork Pressure Class Schedule:

1. Constant Volume Supply: 1-inch wg, regardless of velocity.
2. Return and Relief: 1/2-inch wg.
3. General Exhaust: 1/2-inch wg.
4. Dishwasher Exhaust: 1/2-inch wg.

END OF SECTION 233100

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SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Back-draft dampers.
2. Duct access doors.
3. Volume control dampers.
4. Flexible duct connections.

B. Related Sections:

1. Section 230900 - Instrumentation and Control for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
2. Section 233100 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.

1.2 REFERENCES

A. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

B. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data for shop fabricated assemblies and hardware used.

C. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.

1. Backdraft dampers.
2. Flexible duct connections.
3. Volume control dampers.
4. Duct access doors.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of access doors.

1.5 QUALITY ASSURANCE

- A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
- B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
- C. Perform Work in accordance with codes adopted by the authority having jurisdiction.
- D. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work where appropriate with building control Work.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 BACK-DRAFT DAMPERS

- A. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized, extruded aluminum. Blades, maximum 6 inch width,, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure. Damper leakage shall comply with 2009 IECC requirement of no more than 4.0 cfm/ft² at 1.0 inch w.c. differential pressure.

2.2 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1-inch thick insulation with sheet metal cover.
 - 1. Less than 12 inches square, secure with sash locks.
 - 2. Up to 18 inches Square: Furnish two hinges and two sash locks.
 - 3. Access panels with sheet metal screw fasteners are not acceptable.

2.3 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.
- C. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings.
- D. Quadrants:

1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.4 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Connector: Fabric crimped into metal edging strip.
 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
 2. Net Fabric Width: Approximately 3 inches wide.
 3. Metal: 3 inch wide, 24 gage galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify ducts and equipment installation are ready for accessories.
- C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

- A. Install in accordance with NFPA 90A and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 233100 for duct construction and pressure class.
- B. Install Work in accordance with codes adopted by the authority having jurisdiction.
- C. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.
- D. Access Doors: Install access doors at the following locations and as indicated on Drawings:
 1. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96.
- E. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated on Drawings. Review locations prior to fabrication.

END OF SECTION 233300

SECTION 233400 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Upblast centrifugal roof fans.
 - 2. Ceiling fans.
 - 3. Inline ceiling fans.
 - 4. Centrifugal square inline fans.
- B. Related Sections:
 - 1. Section 230700 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
 - 2. Section 230900 - Instrumentation and Control for HVAC: Product requirements for control components to interface with fans.
 - 3. Section 233100 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
 - 4. Section 233300 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
 - 5. Section 260503 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 - 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. ASTM International:
 - 1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
- D. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.

2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. Underwriters Laboratories Inc.:

1. UL 705 - Power Ventilators.

1.3 PERFORMANCE REQUIREMENTS

- A. Wind-Borne Debris Loads: Design louvers located within 30 feet of grade to withstand ASTM E1996; large missile impact test.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit fan manufacturer instructions.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- D. Balance Quality: Conform to AMCA 204.
- E. Perform Work in accordance with codes adopted by the authority having jurisdiction.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Protect motors, shafts, and bearings from weather and construction dust.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

1.12 MAINTENANCE SERVICE

- A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Furnish service and maintenance of fans for one year from Date of Substantial Completion.
- C. Examine each fan components bi-monthly. Clean, adjust, and lubricate equipment.
- D. Include systematic examination, adjustment, and lubrication of fans, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- E. Perform work without removing fans from service during building normal occupied hours.
- F. Provide emergency call back service during working hours for this maintenance period.
- G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

- H. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.
- I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.13 EXTRA MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of belts for each fan.

PART 2 - PRODUCTS

2.1 EF-1 AND EF-4 UPBLAST CENTRIFUGAL ROOF FANS

- A. Fan Unit: Upblast type. Direct drive, spun aluminum housing with resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- B. Motor: Open drip proof, ECM where indicated in *Fan Schedule* on Drawings.
- C. EF-1 Roof Curb: 16 inch high of galvanized steel or aluminum construction with continuously welded seams, 1 inch insulation and curb bottom, and factory installed nailer strip.
- D. EF-4 Roof Curb: 36 inch high of galvanized steel construction with continuously welded seams, 1 inch insulation and curb bottom, and factory installed nailer strip.
- E. Accessories:
 - 1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.
 - 2. Fan speed controller to be mounted in fan motor enclosure.
- F. Performance and Electrical Characteristics and Components: Refer to *Fan Schedule* on Drawings.

2.2 EF-2 AND EF-3 UPBLAST CENTRIFUGAL ROOF FANS

- A. Fan Unit: Upblast type. V-belt drive, spun aluminum housing with grease tray; resilient mounted electronically commutated motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- B. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- C. Motor: Totally enclosed fan cooled electronically commutated utilizing 0-10Vdc control signal.

- D. Roof Curb: Constructed to interface with metal roof, 16 inch high self-flashing of galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, ventilated double wall, hinged curb adapter.
- E. Performance and Electrical Characteristics: Refer to *Fan Schedule* on Drawings.

2.3 EF-5, EF-6, EF-7, EF-8, CF-1, AND CF-2 CEILING FANS

- A. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with 1/2 inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge opening, integral outlet duct collar.
- B. Disconnect Switch: Cord and plug in housing for thermal overload protected motor.
- C. Grille: Aluminum with baked white enamel finish or painted steel.
- D. Wheel: Centrifugal forward curved type constructed of injection molded or polypropylene resin.
- E. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection.
- F. Accessories:
 - 1. Rubber-in-shear vibration isolator.
 - 2. Fan speed controller.
- G. Performance and Electrical Characteristics and Components: Refer to *Fan Schedule* on Drawings.

2.4 SF-1 INLINE CEILING FANS

- A. Configuration: Inline.
- B. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with 1/2 inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge opening, integral inlet and outlet duct collar.
- C. Disconnect Switch: Cord and plug in housing for thermal overload protected motor.
- D. Wheel: Centrifugal forward curved type constructed of injection molded or polypropylene resin.
- E. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection, mounted on rubber-shear isolators.
- F. Performance and Electrical Characteristics and Components: Refer to *Fan Schedule* on Drawings.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.2 PREPARATION

- A. Furnish roof curbs to General Contractor for installation.

3.3 INSTALLATION

- A. Secure roof fans with cadmium plated steel or stainless steel lag screws to roof curb.
- B. Suspended Cabinet Fans: Install flexible connections specified in Section 233300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Install backdraft dampers on inlet to roof exhaust fans that are specified to include them.
- D. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.
- E. Install safety screen where inlet or outlet is exposed.
- F. Provide sheaves required for final air balance.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Section 014000 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.5 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean inside of fan cabinet.

3.6 DEMONSTRATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

- B. Demonstrate fan operation and maintenance procedures.

3.7 PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 233400

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SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diffusers.
2. Registers
3. Grilles.
4. Louvers.
5. Goosenecks.

B. Related Sections:

1. Section 233300 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

- A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500.
- C. Perform Work in accordance with codes adopted by the authority having jurisdiction.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS, AND DIFFUSERS

- A. Refer to *Grilles, Registers, and Diffusers Schedule* on Drawings.

2.2 LR-1 LOUVERS

- A. Product Description: Stationary Drainable.
- B. Type: 4 inch deep with blades on 37.5 degree slope, heavy channel frame.
- C. Fabrication: 0.081 inch thick extruded aluminum, welded assembly, with factory anodized or fluoropolymer spray finish; Architect will choose from manufacturer's full selection of solid colors.
- D. Blades: Drainable 0.081 inch thick aluminum.
- E. Mounting: Furnish with standard channel frame with screw holes in jambs for installation.
- F. Insect Screen: Aluminum mesh, set in aluminum frame, removable for cleaning.
- G. Performance, Manufacturer, and model: Refer to *Louver Schedule* on Drawings.

2.3 GOOSENECKS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, of minimum 18 gage galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify inlet and outlet locations.
- C. Verify ceiling systems are ready for installation.

3.2 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, unless indicated to include balancing damper in *Grilles, Registers, and Diffusers Schedule*.
- C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 099000.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION 233700

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SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Type B double wall gas vents.
- B. Related Sections:
 - 1. Section 230529 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers and supports for placement by this section.
 - 2. Section 230700 - HVAC Insulation: Execution requirements for insulation specified by this section.
 - 3. Section 235500 - Fuel-Fired Heaters: Fuel fired heaters using breeching, chimneys, and stacks.

1.2 REFERENCES

- A. ASTM International:
- B. NFPA:
 - 1. NFPA 54 - National Fuel Gas Code.
 - 2. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- C. Underwriters Laboratories Inc.:
 - 1. UL 441 - Standard for Gas Vents.

1.3 DEFINITIONS

- A. Breeching: Vent connector.
- B. Vent: Portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- C. Vent Connector: Part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittals procedures.
- B. Product Data: Submit data for Type B Double Wall Gas Vents.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with codes adopted by authority having jurisdiction.
- B. Provide factory built vents and chimneys used for venting natural draft appliances complying with NFPA 211 and UL listed and labeled.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this Section.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Maintain water integrity of roof during and after installation of chimney or vent.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 TYPE B DOUBLE WALL GAS VENTS

- A. Fabrication: Inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, tested in compliance with UL 441.

PART 3 - EXECUTION

3.1 PREPARATION

3.2 INSTALLATION

- A. Install in accordance with NFPA 54.
- B. For Type B double wall gas vents, maintain UL listed minimum clearances from combustibles. Assemble pipe and accessories for complete installation.
- C. Provide Type B chimney continuously from appliances.
- D. Extend vent above roof in accordance with applicable code.
- E. Maximum Vent Horizontal Distance: 75 percent of vent vertical distance.
- F. Do not penetrate metal roof at seam. Center roof penetrations between seams.

END OF SECTION 235100

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SECTION 235500 - FUEL-FIRED HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gas fired unit heaters.
2. Fuel fired packaged air units.

B. Related Sections:

1. Section 230529 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers for placement by this section.
2. Section 230900 - Instrumentation and Control for HVAC: Product requirements for thermostats and time clocks for placement by this section.
3. Section 231123 - Facility Natural-Gas Piping: Product requirements for natural gas piping connected to gas-fired heaters.
4. Section 233300 - Air Duct Accessories: Product requirements for flexible duct connections.
5. Section 235100 - Breechings, Chimneys, and Stacks: Product requirements for vents for placement by this section.
6. Section 260503 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI Z83.8 - Gas Unit Heaters.
2. ANSI Z83.9 - Gas-Fired Duct Furnaces.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.
2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
3. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
4. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

- B. Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of thermostats or other products not mounted on unit.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.5 QUALITY ASSURANCE

- A. Gas-Fired Unit Heater Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with ANSI Z83.8.
- B. Gas-Fired Duct Furnace Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with ANSI Z83.9.
- C. Perform Work in accordance with codes adopted by the authority having jurisdiction.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Accept heaters and controls on site in factory packaging. Inspect for damage.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

1.11 EXTRA MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two throwaway filters for each unit requiring filters.

PART 2 - PRODUCTS

2.1 UH-1 THROUGH UH-11 GAS FIRED UNIT HEATERS

- A. Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
 - 1. Heating fuel: Natural gas fired.
 - 2. Discharge Louvers: Individually adjustable horizontal and vertical louvers to match cabinet finish.
 - 3. Gas Control: Single stage.
 - 4. Ignition System: Electric ignition-pilot to main burner or electric direct ignition.
 - 5. Control Voltage: 24 volt, 60 hertz.
 - 6. Location: Suspended overhead.
- B. Cabinet: Galvanized steel, easily removed and secured access panels, insulated or double panel construction.
- C. Supply Fan: Propeller type with direct drive.
- D. Heat Exchanger: Aluminized steel welded construction.
- E. Gas Burner: Power-vented with non-corrosive air blower with permanently lubricated motor.
- F. Gas Burner Safety Controls:
 - 1. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
 - 2. Flame rollout switch: Installed on burner box and prevents operation.
 - 3. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
 - 4. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic reset.
- G. Controls:
 - 1. Room Thermostat: Adjustable, low voltage, to control burner operation, and supply fan to maintain temperature setting.

2. Supply Fan Control: Energize either from discharge temperature independent of burner controls or with timed off delay and timed on delay. Furnish manual switch for continuous fan operation.

H. Performance:

1. Refer to *Unit Heater Schedule* on Drawings.

2.2 MA-1 FUEL FIRED PACKAGED AIR UNITS

- A. Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet and supply fan assembly, and duct furnaces each consisting of heat exchanger and burner.
- B. Roof Curb: Spring vibration isolating roof curb under entire unit.
- C. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access-doors, double wall with glass fiber insulation.
- D. Supply Fan: Centrifugal type rubber mounted with belt drive, variable pitch motor pulley.
- E. Filter: 2 inch thick pleated MERV 8 throwaway type, located to filter air before fan.
- F. Gas Fired Duct Furnace Units:
 1. Heat Exchanger: Type E-3 stainless steel or Type 316 stainless steel welded construction suitable for 100% outdoor air.
 2. Gas Burner:
 - a. Power vented type.
 - b. Gas valve modulating, provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, automatic electric valve.
 - c. Direct spark igniter.
 - d. Vertical flue discharge.
 3. Gas Burner Safety Controls:
 - a. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic resets.
 4. Performance:
 - a. Refer to *Makeup Air Unit Schedule* on Drawings.
- G. Dampers:
 1. Dampers: Outside air damper with damper operator and control package to automatically close damper when unit is not operating. Outside air damper fail to closed position.
 2. Gaskets: Fit dampers with edge gaskets, maximum leakage 4 cfm/ft² at 1 inch wg pressure differential.
 3. Damper Operator: 24 volt with gear train with spring return.
- H. Evaporative Cooler Module:
 1. 12 inch thick rigid cellulose evaporative media.
 2. Thermally protected water pump.

3. Electrical motor-protection float switch with stainless steel float and arm,
4. PVC float valve and bleed line.
5. 115V power requirement.
6. Overflow and drain connections.
7. Stainless steel water reservoir
8. Automatic fill and drain kit, 3-way water solenoid valve, 2-way normally open drain solenoid valve, line voltage remote bulb thermostat with DPDT contacts, 120VAC.

I. Controls:

1. Adjustable discharge air temperature duct thermostat to modulate burner.
2. Outdoor air thermostat to determine heating or cooling mode.
3. Manual-reset freezestat to shut down unit in event of burner failure to fire.
4. Control board with LED diagnostic indicator lights.
5. Control panel with necessary components and wiring to achieve sequence specified for MA-1 in section 230993.

J. Performance, Electrical Characteristics, Manufacturer, and Model:

1. Refer to *Makeup Air Unit* Schedule on Drawings.

2.3 FUEL FIRED PACKAGED AIR UNITS MA-2

- A. Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet and supply fan assembly, and duct furnaces each consisting of heat exchanger and burner.
- B. Roof Curb: Insulated spring vibration isolating roof curb under unit except mixing box.
- C. Cabinet:
1. Galvanized steel with baked enamel finish, easily removed and secured access-doors, glass fiber insulation and double wall.
 2. All sections supported on one set of base rails with mixing box and intake hood cantilevered without curb support to allow duct from above roof to connect under unit. Refer to Detail on Drawings.
- D. Supply Fan: Centrifugal type vibration isolation mounted with belt drive, variable pitch motor pulley.
- E. Filter: 2 inch thick pleated MERV 8 throwaway type, located to filter air before fan.
- F. Gas Fired Duct Furnace Units:
1. Heat Exchanger: Type E-3 stainless steel or Type 321 stainless steel welded construction suitable for 100% outdoor air.
 2. Gas Burner:
 - a. Type E-3 stainless steel burner and drip pan.
 - b. Power vented type.
 - c. Gas valve electronic modulating, provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
 - d. Spark pilot igniter.

- e. Non-corrosive combustion air blower with permanently lubricated motor.
 - f. Vertical flue discharge.
- 3. Gas Burner Safety Controls:
 - a. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
 - b. Flame rollout switch: Installed on burner box and prevents operation.
 - c. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
 - d. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic resets.
- 4. Vertical flue discharge kit.
- G. Cooling Coil Section:
 - 1. Weatherized cooling coil cabinet, galvanized steel, insulated, with condensate drain trough.
 - 2. Direct expansion cooling coil, refrigerant R410A, thermal expansion valve.
- H. Mixing Dampers:
 - 1. Mixing box, dampers, and actuator provided by Mechanical Contractor, not provided by unit manufacturer.
 - 2. Mixed Air Control Sequence: Refer to specification section 230993 for control sequences. Unit manufacturer shall include controls for outdoor air and return air modulating actuator for economizer and ventilation control.
- I. Inlet Hood: Outside air screened inlet hood with moisture eliminator louvers.
- J. Controls:
 - 1. Adjustable, 7-day programmable room thermostat, low voltage, to control heating and cooling operation to maintain space temperature setting and control occupied/unoccupied modes.
 - 2. Manual-reset freezestat to shut down unit in event of burner failure to fire.
 - 3. Control board with LED diagnostic indicator lights.
 - 4. Controls system as required to provide control sequences specified for MA-2 in section 230993.
 - 5. Return air smoke detector with remote annunciator/test stations for ceiling mounting.
- K. Performance, Electrical Characteristics, Manufacturer, and Model:
 - 1. Refer to *Makeup Air Unit* Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify space is ready for installation of units and openings are as indicated on shop drawings.

3.2 INSTALLATION

- A. Install units in accordance with NFPA 90A and NFPA 90B and gas fired units to NFPA 54.
- B. Installation - Natural Gas Piping:
 - 1. Connect natural gas piping in accordance with NFPA 54.
 - 2. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
 - 3. Install the following piping accessories on natural gas piping connections. Refer to Section 231123.
 - a. Shutoff valve.
 - b. Pressure reducing valve and related fittings.
 - c. Flexible piping connector.
- C. Install vent connections in accordance with NFPA 211. Install vents and stacks. Refer to Section 235100.
- D. Provide hangers and supports for suspended units.
- E. Install return air duct smoke detector where indicated on Plan and wire to shut down unit upon detection of smoke.
- F. Deliver duct smoke detector remote annunciator/test station for MA-2 to Fire Alarm Contractor for installation.
- G. Provide operating controls. Refer to Section 230900.
- H. Provide connection to electrical power systems. Refer to Section 260503.

END OF SECTION 235500

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SECTION 237416.11 - PACKAGED, SMALL-CAPACITY, ROOFTOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged rooftop air conditioning unit.
2. Roof curb.

B. Related Sections:

1. Section 230993 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
2. Section 231123 - Facility Natural-Gas Piping: Natural gas piping connections.
3. Section 233300 - Air Duct Accessories: Flexible connections.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

B. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.
3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

E. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.
2. NFPA 58 - Liquefied Petroleum Gas Code.
3. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 DEFINITIONS

- A. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.
- B. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling (in Btu) divided by total electric energy input during the same period (in Wh).

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating:
 - 1. Cooling and heating capacities.
 - 2. Dimensions.
 - 3. Weights.
 - 4. Rough-in connections and connection requirements.
 - 5. Duct connections.
 - 6. Electrical requirements with electrical characteristics and connection requirements.
 - 7. Controls.
 - 8. Accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of controls installed remotely from units.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.6 QUALITY ASSURANCE

- A. Cooling Capacity: Rate in accordance with ARI 210/240 or ARI 340/360.
- B. Sound Rating: Measure in accordance with ARI 270.
- C. Insulation and adhesives: Meet requirements of NFPA 90A.
- D. Performance Requirements: Conform to minimum EER and SEER prescribed by ASHRAE 90.1 when tested in accordance with ARI 210/240 or ARI 340/360.
- E. Outside Air Damper Leakage: Test in accordance with AMCA 500.
- F. Perform Work in accordance with codes adopted by the authority having jurisdiction.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Accept units on site. Inspect for damage.
- C. Protect units from damage by storing off roof until roof mounting curbs are in place.

1.10 COORDINATION

- A. Section 013000 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of roof curbs with roof structure, roof deck and roof membrane installation.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

1.12 MAINTENANCE SERVICE

- A. Section 017000 - Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.
- C. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period.

1.13 EXTRA MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish one set of filters and fan belts for each unit.

PART 2 - PRODUCTS

2.1 RTU-1, RTU-2, RTU-3, AND RTU-4 ROOFTOP AIR CONDITIONING UNITS

- A. Product Description: Self-contained, packaged, factory assembled and wired, consisting of roof curb, cabinet, supply fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, gas-fired heating section, air filters, mixed air casing, controls, and accessories.
- B. Configuration: As indicated on Drawings.
- C. Roof Mounting Curb: Vibration isolating, 24 inch high, galvanized steel, channel frame with gaskets, nailer strips, spring isolators, and weather seal. Full perimeter type for mounting under entire unit.
- D. Cabinet:
 - 1. Designed for outdoor installation with weatherproof construction.
 - 2. Panels: Constructed of galvanized steel with baked enamel finish meeting salt spray test in accordance with ASTM B117. Furnish access doors or removable access panels.
 - 3. Insulation: Factory applied to exposed vertical and horizontal panels. Minimum of 1/2 inch thick neoprene coated glass fiber with edges protected from erosion.
- E. RTU-2 and RTU-4 Supply Fan: Forward curved centrifugal type, resiliently mounted with direct drive EC motor. Motor permanently lubricated with built-in thermal overload protection.
- F. RTU-1 and RTU-3 Supply Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.
- G. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Galvanized steel, stainless steel, or plastic drain pan with piping connection. Factory leak tested under water.
- H. Compressor: Hermetically sealed, resiliently mounted with positive lubrication, and internal motor overload protection. Furnish internal vibration isolators and/or external vibration isolators, and short cycle protection.
- I. Refrigeration circuit: Furnish the following for each circuit thermal expansion valve, filter-drier, high and low pressure safety controls,. Dehydrate and factory charge each circuit with oil and refrigerant.
- J. Condenser:
 - 1. Coil: Copper tube aluminum fin coil assembly with subcooling rows and coil guard. Factory leak tested under water.

2. Condenser Fan: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Motor permanently lubricated with built-in thermal overload protection.
- K. Gas-Fired Heating Section:
1. Fuel: Natural gas.
 2. Heat Exchangers: Aluminized steel, welded construction.
 3. Gas Burner: Induced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, direct spark ignition, flame sensing device, and. Require unit fan operation before allowing gas valve to open.
 4. Gas piping shall penetrate roof beside each unit.
 5. Upward flue discharge accessory for RTU-1, RTU-2, and RTU-3.
- L. Air Filters: 2-inch-thick glass fiber disposable media in metal frames, MERV 8 rating.
- M. Mixed Air Casing:
1. Outside Air Damper Leakage: Maximum Damper leakage shall comply with 2009 IECC requirement of no more than 4.0 cfm/ft² at 1.0 inch w.c. differential pressure.
 2. Economizer: Fully modulating motorized outside air and return air dampers controlled by dry bulb controller with minimum position setting, Honeywell model W7220 or equivalent. Outside air damper normally closed and return air damper normally open. Furnish barometric relief damper with powered exhaust and rain hood with screen. Provide economizer components and controls in accordance with 2009 IECC.
- N. Controls:
1. Furnish low limit thermostat in supply air to close outside air damper and stop supply fan.
 2. Thermostat: 7-day programmable electronic space thermostat with number of stages of heating and cooling matching stages provided by RTU, with automatic changeover and heating setback and cooling setup capability. Furnish system selector switch off-heat-auto-cool and fan control switch, auto-on.
 3. Microprocessor Based Controls:
 - a. Factory mounted with the following features:
 - 1) Monitor each mode of operation.
 - 2) Evaporator fan status.
 - 3) Filter status.
 - 4) Indoor air quality.
 - 5) Supply air temperature.
 - 6) Outdoor air temperature.
 - b. Factory installed return air smoke detector on RTU-1 and RTU-3 with remote annunciator/test stations for ceiling mounting.
 - c. Diagnostics for thermostat commands for staged heating, staged cooling, fan operation, and economizer operation.
 - d. Zone space temperature sensor to interface with microprocessor controls with Automatic programmable with night setback.
- O. Capacity and Electrical Characteristics: Refer to *Rooftop HVAC Unit Schedule* on Drawings.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 PREPARATION

- A. Furnish roof curbs to General Contractor for installation with assistance of Mechanical Contractor.

3.3 INSTALLATION

- A. Roof Curb:
 - 1. Assemble roof curb.
 - 2. Install roof curb level.
 - 3. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
 - 4. Install gasket material between unit base and roof curb.
- B. Install roof mounted units on vibration isolating roof curbs.
- C. Install ground mounted units on 3-1/2-inch tall concrete housekeeping pad.
- D. Connect units to supply and return ductwork with flexible connections. Refer to Section 233300. Provide sheet metal sun shields for flexible connectors located outdoors.
- E. Install condensate piping with trap and route from drain pan to splash block on roof.
- F. Install components furnished loose for field mounting.
- G. Deliver duct smoke detector remote annunciator/test stations to Fire Alarm Contractor for installation.
- H. Install electrical devices furnished loose for field mounting.
- I. Install control wiring between unit and field installed accessories.
- J. Remove from roof and dispose off-site panels removed from units during installation of economizer and dampers.

3.4 INSTALLATION - NATURAL GAS HEATING SECTION

- A. Connect natural gas piping in accordance with NFPA 54.

- B. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
- C. Install the following piping accessories on natural gas piping connections. Refer to Section 231123.
 - 1. Shutoff valve.
 - 2. Pressure reducing valve.
 - 3. Flexible pipe connector.
- D. Install natural gas piping accessories above roof.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Section 014000 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.6 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Install new throwaway filters in units at Substantial Completion.
- D. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion. Do not run unit during construction until all dust-producing activities have been completed.

3.7 DEMONSTRATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer and Owner of training date.

END OF SECTION 237416.11

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SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Condensing unit.
- B. Related Sections:
 - 1. Section 230993 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
 - 2. Section 232300 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
 - 3. Section 260503 - Equipment Wiring Connections: Electrical connection to units.

1.2 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- D. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating:
 - 1. Cooling capacities.
 - 2. Dimensions.
 - 3. Weights.
 - 4. Rough-in connections and connection requirements.
 - 5. Electrical requirements with electrical characteristics and connection requirements.
 - 6. Controls.
 - 7. Accessories.
- C. Manufacturer's Field Reports: Submit start-up report.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of controls installed remotely from units.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

- A. Performance Requirements: <Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with AHRI 365.
- B. Cooling Capacity: Rate in accordance with AHRI 365.
- C. Sound Rating: Measure in accordance with AHRI 270.
- D. Insulation and adhesives: Meet requirements of NFPA 90A.
- E. Perform Work in accordance with codes adopted by the authority having jurisdiction.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 COORDINATION

- A. Section 013000 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of condensing units with roof structure.

1.10 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five-year manufacturer's warranty for compressors.

1.11 MAINTENANCE SERVICE

- A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.
- C. Furnish emergency service on breakdowns and malfunctions for this maintenance period. Furnish capability of response time within 8 hours.

1.12 MAINTENANCE MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

PART 2 - PRODUCTS

2.1 CONDENSING UNIT CU-1

- A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.
- B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.
- C. Compressor: Two independent refrigeration circuits with rotary scroll type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection. One compressor shall include digital unloading for capacity modulation.
- D. Condenser Coil: Constructed of copper tubing mechanically bonded to aluminum fins, factory leak and pressure tested.

- E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.
- F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection.
- G. Condensing Unit Accessories: Furnish the following accessories:
 - 1. Time delay relay.
 - 2. Anti-short cycle timer.
 - 3. Vibration isolators.
 - 4. Condenser Coil Guard: Condenser fan openings furnished with hail guards.
- H. Refrigeration specialties: Furnish the following for each circuit:
 - 1. Suction line shutoff valve.
 - 2. Liquid line shutoff valve.
 - 3. Suction line accumulator.
 - 4. Pressure transducers.
 - 5. Charge of compressor oil.
 - 6. Holding charge of refrigerant or nitrogen.
 - 7. Charging valve or port.
 - 8. Crankcase heater.
 - 9. Pressure relief device.
- I. Refrigerant: Furnish charge of refrigerant R-410A.

2.2 Controls

- A. Factory wired and mounted control panel, containing fan motor starters, fan cycling thermostats or speed controls, compressor interlock and control transformer.
- B. Furnish controls to permit operation down to 55 degrees F ambient temperature.
- C. Furnish thermostat or pressure controls to cycle and vary speed of fan motors in response to outdoor temperature or condensing pressure.
- D. Furnish solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.
- E. Furnish digital controller capable of multiple modes of compressor control including discharge air control. Refer to specification section 230993 for control sequence. Controller shall include 60-character LED data display.

2.3 PERFORMANCE AND ELECTRICAL CHARACTERISTICS

- A. Refer to *Condensing Unit* Schedule on Drawings for performance and electrical characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify supports for condensing unit is ready for unit installation.

3.2 INSTALLATION - CONDENSING UNIT

- A. Install condensing units on vibration isolators.
- B. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties specified in Section 232300.
- C. Evacuate refrigerant piping and install initial charge of refrigerant.
- D. Install electrical devices furnished loose for field mounting.
- E. Install control wiring between makeup air unit, condensing unit, and field installed accessories.
- F. Install connection to electrical power wiring in accordance with Section 260503.
- G. Install Work in accordance with codes adopted by the authority having jurisdiction.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Section 014000 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.4 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.

3.5 DEMONSTRATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate starting, maintenance, and operation of condensing unit.

- C. Furnish services of manufacturer's technical representative for 4 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Owner of training date.

3.6 PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

END OF SECTION 238126

SECTION 260400 - BASIC ELECTRICAL REQUIREMENTS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.
- B. Where a panel is installed, at least 25% of panel capacity, accounting for serving panel capacity, shall remain as spare capacity with regard to calculated load and space capacity after project completion.
- C. Where existing panels are used for additional work, when six (6) or less spaces remain a new panel shall be installed.
- D. All electrical/electronic circuits, including audio, video and fire alarm systems, shall be in an approved raceway system. No "wild circuits" will be accepted.
- E. Related Sections:
 - 1. Basic Electrical Requirements specifically applicable to all Division 26 Sections, in addition to Division 1 General Requirements, and Divisions 11, 14, 21, 22, 23, 27 and 28.
 - 2. All electrical/electronic circuits and equipment from any other Division shall meet the requirements of Division 26.
 - 3. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the Contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.
 - 4. Temporary Power: See Division 1 for construction power constraints.
- F. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- G. Latest editions of the following:

1. ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Authority Having Jurisdiction).
2. International Fire Code (as amended by the local Fire Department).
3. International Building Code (as adopted and amended by the local Building Department).
4. International Energy Conservation Code (as adopted and amended by the Authority Having jurisdiction).
5. ANSI/IEEE C2 - National Electrical Safety Code.
6. OSHA - Occupational Safety and Health Administration, as Amended
7. Underwriter's Laboratory (UL).
8. National Fire Protection Association (NFPA).
9. Other references as listed elsewhere in these specifications.
10. IEEE Standard 519- Recommended Practices and Requirement for Harmonic Control in Electrical Power Systems.
11. NECA 1 - Good Workmanship in Electrical Construction

1.3 DEFINITIONS

- A. "Furnish" or "Provide": To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.
- B. "Install": To erect, mount and connect complete with related accessories.
- C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
- D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- E. "Wiring": Raceway, fittings, wire, boxes and related items.
- F. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.
- G. "Or Equal". Or "Approved Equal": Refers to products that, in the opinion of the Project Manager, are similar in all respect to products specified by proprietary brand name. (Refer to Section 01 for procedures for submittal of proposed substitutions.)
- H. "Exposed": Not installed underground or "concealed" as defined above.
- I. "Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.
- J. "Similar" or "Equal": Same in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.
- K. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by the Project Manager.

- L. "Related Work" includes all "Work" required for a complete working system.
- M. "Equipment": A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation.
- N. "Busbar": A rigid metallic conductor, lug or bar used to make a common connection between more than one circuit. (Includes all termination assemblies.)
- O. "Shall": Mandatory requirements of this specification are characterized by the use of the word "shall".
- P. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this Project.

1.4 WORK SEQUENCE

- A. Construct Work in sequence under provisions of Division 1 where applicable.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The Drawings indicate the general arrangement of circuits, outlets, panelboards and other work. Information shown on the Drawings is schematic; however, re-circuiting will not be permitted without specific acceptance. In cases of conflict between specifications and drawings, the specification shall have precedence. Data presented on the drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is required. Review all of the Contract Documents and adjust all work to conform to all conditions shown therein.
- B. Prior to submitting a bid, a site visit is required to ascertain all conditions affecting the proposed installation and to adjust all work accordingly. Costs for providing for these adjustments, including response to site constraints, shall be itemized and listed in the bid proposal.
- C. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the Project Manager in writing 72 hours before the date of bid opening. In the event such discrepancies exist, and the Project Manager is not so notified, the adjudication of responsibility shall be solely at the discretion of the Project Manager.

1.6 COORDINATION

- A. As a first order of business and before any ground work by other contractors, coordinate utility requirements and service riser placement.
- B. Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the

direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.

- C. Any electrical work penetrating concrete walls or floors shall require saw cutting and/or core drilling and shall require approval by the Project Manager. The Contractor shall perform all necessary imaging (x-rays, etc.) as specified, and submit shop drawings of any saw cutting or core drilling to the Project Manager prior to performing the Work. Refer to Division 1 "Cutting and Patching" for additional requirements.
- D. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with the Project Manager. A written shutdown request form shall be submitted to and approved by the Project Manager two (2) weeks prior to the shutdown.

1.7 COORDINATION DRAWINGS

- A. Where the Contractor modifies the design, through selection or placement of equipment differing from that shown, coordination drawings shall be provided by the Contractor in accordance with Division 1 to a scale of 1/4"=1'0" or larger for equipment rooms, details, congested areas and sections; other plans at a scale of 1/8"=1'0" or 3/16"=1'0" as appropriate. These drawings are to detail major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components.
- B. Coordination drawings shall be in accordance with current standards for format, and as outlined in Division 1.
- C. The Contractor shall indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. Indicate the proposed locations of raceway systems, equipment, and materials. Include the following:
 - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
 - b. Exterior wall and foundation penetrations.
 - c. Fire-rated wall and floor penetrations.
 - d. Equipment connections and support details.
 - e. Sizes and location of required concrete pads and bases.
 - f. Support details.
 - 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 - 3. Floor plans, elevations, and appropriate details are required to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

1.8 SUBMITTALS

- A. Refer to Division 1 "Submittals".
- B. Submit shop drawings, coordination drawings and product data in accordance with provisions of Division 1. Submit all required information under a given specification section together. Do not split out submittals under the same specification section.
- C. Prior to submission, shop drawings, material lists and catalog cut sheets or manufacturer's printed data shall be thoroughly checked for compliance with Contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.
- D. Clearly mark each shop drawing as follows for purposes of identification:
 - 1. Shop Drawing.
 - 2. Equipment Identification Used on Contract Drawings.
 - 3. Date.
 - 4. Name of Project.
 - 5. Branch of Work.
 - 6. Project Manager's Name.
 - 7. Contractor's Name.
- E. Clearly mark printed material, catalog cut sheets, pamphlets or specification sheets, and shop drawings with the same designation shown on the Contract document schedules. Contractor agrees that submittals processed by the Project Manager are not change orders; that the purpose of submittals is to demonstrate to the Project Manager that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material the Contractor intends to furnish and install and by detailing the installation methods the Contractor intends to use.
- A. Include manufacturer's clearance requirements for obstructions and walls, include shop drawings of the location where the equipment is to be located and depicting the clearance requirements are being met.
- F. Contractor shall be responsible for dimensions (which the Contractor shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of the Contractor's Work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.
- G. Maintain one copy of accepted shop drawings at the Project field office until completion of the Project, and make this copy available, upon request, to representatives of the Project Manager and Owner.
- H. No equipment or materials shall be installed or stored at the jobsite until submittals for

such equipment or materials have been given review action by the Project Manager accepting their use.

- I. Shop drawings and manufacturer's published data shall be submitted for all equipment required for this Project.

1.9 RECORD DOCUMENTS

- A. Maintain a Contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the Project Manager at all times. Upon completion of the Contract, this set of record drawings shall be delivered to the Owner.

1. Provide horizontal and vertical dimensions for all raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.10 REGULATORY REQUIREMENTS

- A. Obtain all permits, plan review, and inspections from authority having jurisdiction.
- B. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than the drawings and specifications.

1.11 ENVIRONMENTAL CONDITIONS

- A. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:
 1. Location: Indoors/Outdoors.
 2. Altitude: 4,500 feet above sea level.
 3. Temperature range: -30°F to 120°F.

1.12 WARRANTY

- A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment

which evidences defects in design, construction, or workmanship within two (2) years, or any longer period specifically noted elsewhere in these specifications, from date of substantial completion.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.
- B. All equipment and materials installed shall be new, unless otherwise specified.
- C. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the Project Manager or Owner and at no additional cost to the Owner.
- D. All electrical "equipment" and assemblies shall be acceptable for installation only if labeled and listed by a nationally recognized testing laboratory, such as UL or an equivalent.
- E. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

2.2 STORAGE AND PROTECTION

- A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.
- B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering and provide ventilation to avoid condensation.
- C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

2.3 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only:
 - 1. Any product meeting those standards.
- B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions:

1. Submit a request for substitution for any manufacturer not specifically named with supporting documentation for approval by Project Manager.

2.4 PRODUCTS LIST

- A. Within fifteen (15) days after date of Notice to Proceed, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

2.5 SUBSTITUTIONS

- A. Refer to Division 1 General Requirements.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Only quality workmanship will be accepted. Poor workmanship, improper layout of work and lack of coordination of Work, as determined by the Project Manager, are not acceptable and shall be corrected at the contractor's cost.
- B. Contractor shall include no more than one apprentice per Journeyman Electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.
- C. Any changes or deviations from the drawings and specifications must be accepted in writing by the Project Manager. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.
- D. Upon completion of Work, all equipment and materials shall be installed complete, thoroughly tested, checked, correctly adjusted, and left ready for intended use or operation. All Work shall be thoroughly cleaned and all residues shall be removed from surfaces. Exterior surfaces of all material and equipment shall be left in a perfect, unblemished condition.
- E. Contractor shall provide a complete installation, including all required labor, material, cartage, testing, insurance, permits, and taxes.

3.2 CHASES, OPENINGS, CUTTING AND PATCHING

- A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the Project Manager. Any necessary cutting,

channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and shall be pre-approved by the Project Manager.

- B. All openings made in fire-rated walls, floors, or ceilings shall be sealed and made tight in a manner to conform to the fire rating for the barrier penetrated. Reference Division 7 for additional information.
- C. All penetrations required through completed concrete construction shall be core drilled at minimum size required. All penetrations in concrete require an x-ray or ground penetrating radar to determine if the location is clear of reinforcing steel and embedded systems. Precautions shall be taken when drilling to prevent damage to structural concrete.

3.3 ELECTRICAL INSTALLATIONS

- A. Coordinate electrical systems, equipment, and material installation with other building components. If the Contractor furnishes equipment of a different size, the Contractor shall furnish and install the proper fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner, and as deemed acceptable by the Project Manager. If the equipment clearance cannot be met, then the contractor shall bear the cost of any and all changes resulting in the alteration or modification of the building or associated equipment, at no additional cost to the owner.

3.4 PROGRESS OF WORK

- A. Coordinate the progress of electrical work to conform to the progress of the Work of the other trades. Complete the entire installation as soon as the condition of the sites will permit. Any cost resulting from defective or ill-timed work performed under Division 26 shall be borne by the Contractor.

3.5 ELECTRICAL COMPLETION

- A. Training of Operating and Maintenance Personnel: Furnish the services of a qualified representative of the supplier of each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.
 - 1. Instruction shall be given when the particular system is complete, shall be of the number of hours indicated, and at the time requested by the Owner. A representative of the Contractor shall be present for all demonstrations.

Systems:	Hours of Instruction:
Lighting controls	2

Systems:	Hours of Instruction:

- B. Operating and Maintenance Manuals and Parts Lists: Deliver three (3) complete operating & maintenance manuals and parts lists in three-ring binders to the Owner at the time of the above required training. The information shall be provided on the manufacturer's original data sheets. Fully explain the contents of the manuals as part of required training and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period.
1. The operating and maintenance manuals and parts lists shall give complete information as to whom the Owner shall contact for service and parts. Include address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within 24 hours after requested.
- C. Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications for all applicable equipment furnished and installed as part of this Contract. Submit three (3) copies of test reports to the Project Manager for the Project Manager's approval.
- D. Clean Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, fixtures, etc. in a clean, orderly condition. Clean all electrical equipment, such as switchboards, panel boards, luminaries etc. of construction dirt, dust, etc. and touch-up or repaint all scratches, blemishes, rust spots etc. to its original condition. Any costs to the Owner for cleanup of the site will be charged against the Contractor.
- E. Acceptance Demonstration: Upon completion of the Work, at a time to be designated by the Project Manager, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided or modified under this Contract.
- F. Final Acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment, as approved by Project Manager.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 260400

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SECTION 260510 - TESTING, ACCEPTANCES AND CERTIFICATION**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 OF REQUIREMENTS

- A. The Contractor shall provide the necessary field-testing and startup services for all electrical and mechanical equipment except as noted otherwise. The field-testing and startup services shall be in accordance with each equipment manufacturer's written recommendations for field-testing proving they meet Contract standards.
- B. The Contractor shall be responsible for furnishing all equipment, power source when needed, coordinating and performing electrical/electronic testing required by the Contract Documents. Testing requirements may be located on the Contract Drawings or other sections of the specifications.
- C. The Contractor shall provide all necessary assistance and cooperation with any Independent Testing Organization furnishing by the owner. The Contractor shall correct, repair, or replace all equipment found to be defective by the Independent Testing Organization.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of these Specifications, all Work specified herein shall conform to or exceed the applicable requirements of the referenced Standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply unless in conflict with the equipment manufacturer's written recommendations:
 - 1. Building Code and MESA COUNTY Standards.
 - 2. ANSI/IEEE C2 - National Electrical Safety Code.
 - 3. OSHA - Occupational Safety and Health Administration, as Amended
 - 4. NETA - National Electric Testing Association
 - 5. NEMA ICS 1 - General Standards for Industrial Control and Systems.
 - 6. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.
 - 7. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
 - 8. UL 1008 - Standard for Automatic Transfer Switches.
 - 9. NFPA 70 - National Electrical Code, including but not limited to use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702.
 - 10. NFPA 72 - National Fire Alarm Code (as adopted and amended by the Mesa

- County Building Code and MESA COUNTY Standards).
11. NFPA 101 - National Electrical Safety Code (as adopted and amended by the Mesa County Building Code and MESA COUNTY Standards).
 12. NFPA 110 - Standard for Emergency and Standby Power Systems (as adopted and amended by the Mesa County Building Code and MESA COUNTY Standards).
 13. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)
 14. NEMA Standard ICS-2-447 - AC Automatic Transfer Switches.
 15. IEC - Standard for Automatic Transfer Switches.

1.4 SUBMITTALS

- A. Comply with Division 1 submittal requirements.
- B. Five (5) copies of complete certified test reports shall be submitted to the Project Manager by the contractor. Electronic copy of test reports in pdf format to also be submitted to the Project Manager. The test reports shall include the following as a minimum:
 1. Power cable high potential test reports:
 - a. Insulation resistance tests.
 - b. Continuity tests.
 2. Transformer test reports to include where applicable:
 - a. Transformer turns ratio.
 - b. Winding resistance.
 - c. Insulation power factor.
 - d. K Factor.
 3. All electrical/electronic equipment and systems functional test report.
 4. All other reports required by individual specification sections.
 5. Generator load bank test report.
 6. Transfer Switch test report.
 7. Load balance report for each switch board, panel board and switch gear.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The electrical and mechanical equipment shall be completely tested in the field in the presence of Inspectors in accordance with good and accepted industry engineering practices to assure that:
 1. The equipment has not been damaged during manufacturing, shipping, or installation.
 2. The equipment has been installed according to the requirements Contract

Documents.

3. The equipment meets the requirements of the Contract Documents.
 - B. If the Contractor finds during the testing that any piece of equipment failed to satisfactorily pass the required field test, the Project Manager shall be promptly notified and the Contractor shall take the necessary actions for the prompt repair or replacement.
 - C. A retest to demonstrate the equipment will meet the requirements of the Contract Documents shall be scheduled with the Project Manager.
- 2.2 Engine generator system (when furnished and installed as part of this contract).
 - A. Test generator operation per tests as specified in Section 263213 "Engine Generators".
- 2.3 Bypass isolation transfer switch (when furnished and installed as part of this contract).
 - A. Test transfer switch operation per tests as specified in Section 263600 "Transfer Switches"
- 2.4 HVAC
 - A. Test the operation of all heaters and air conditioners.
 - B. Test the Lead Lag Control circuits.
- 2.5 GROUND RESISTANCE TEST
 - A. Before connecting a ground rod to the system test the resistance to earth. Where test show resistance to ground over 25 OHMS, an additional ground rod shall be added.
 - B. Upon completion of installation of electrical grounding system, test ground resistance to earth in accordance with ANSI/IEEE81. Submit test results to the Project Manager
- 2.6 CONDUCTOR INSULATION TEST
 - A. Prior to energizing, all building service cables feeders to and/or from transformers, switchboards, panel boards are to be tested with a 1000-volt insulation megohm meter to determine insulation resistance levels. Test cables rated for three hundred volt with a 500-volt megohm meter or as recommended by the manufacturer. All field test data is to be recorded, corrected to a baseline temperature and furnished to the Project Manager. A test is to include meggering between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. Insulation test values shall meet or exceed the values given below:

Conductor Size:

(AWG or KCMIL)

12-8

6-2/0

3/0-750

Resistance:

(Megaohms - 1,000 ft.)

200

100

100

PART 3 - EXECUTION**3.1 FIELD QUALITY CONTROL****A. TESTING**

1. The Contractor shall allow only certified personnel to perform the testing.
2. The Contractor shall perform the testing using all necessary safety precautions and proper test equipment.
3. The Contractor shall notify the Project Manager three (3) days in advance of the proposed testing dates.
4. Witness of testing by owner representative and Electrical Inspector.

PART 4 - MEASUREMENT**4.1 METHOD OF MEASUREMENT**

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT**5.1 METHOD OF PAYMENT**

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 260510

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.

1.2 ACTION SUBMITTALS**A. Product Data:** For each type of product.**1.3 INFORMATIONAL SUBMITTALS****A. Field quality-control reports.****PART 2 - PRODUCTS****2.1 CONDUCTORS AND CABLES**

- A. Aluminum and Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2 Type XHHW-2 Type USE and Type SO.
- C. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for armored cable, Type AC metal-clad cable, Type MC nonmetallic-sheathed cable, Type NM Type SO and Type USE with ground wire.
- D. VFC Cable:
 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
 2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.
 3. Comply with UL requirements for cables in direct burial Classes I and II, Division 2 hazardous location applications.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

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

PART 3 - EXECUTION**3.1 CONDUCTOR MATERIAL APPLICATIONS**

- A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger unless otherwise depicted. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger unless otherwise depicted.
- B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded unless otherwise depicted.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2 or Type USE, single conductors in raceway .
- B. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-2-THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC Nonmetallic-sheathed cable, Type NM.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway
- E. Feeders Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC Nonmetallic-sheathed cable, Type NM.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway
- I. Branch Circuits Installed below Raised Flooring: Type THHN-2-THWN-2, single conductors in raceway
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. VFC Output Circuits: Type XHHW-2 in metal conduit

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- 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 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack measured from the face of the enclosure..

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 7 regarding "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.
 - a. Any conductor rated 100A or more.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters and submit test results prior to covering any work.
- B. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. RS-485 cabling.
 - 2. Low-voltage control cabling.
 - 3. Control-circuit conductors.
 - 4. Identification products.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. 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.

2.2 PERFORMANCE REQUIREMENTS

- A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches (1520 mm) or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

- C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 BACKBOARDS

- A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm) or as depicted on the drawings, label side out. Comply with requirements for plywood backing panels in Section 06100 "Rough Carpentry."
- B. Painting: Do not paint.

2.4 RS-485 CABLE

- A. Plenum-Rated Cable: NFPA 70, Type CMP.
 - 1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - 2. Fluorinated ethylene propylene insulation.
 - 3. Unshielded.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. Flame Resistance: NFPA 262.

2.5 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44 or UL 83.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway , complying with UL 44 or UL 83.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway complying with UL 44 or UL 83.
- D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
 - 1. Smoke control signaling and control circuits.

2.6 SOURCE QUALITY CONTROL

- A. Factory test UTP cables according to TIA-568-C.2.
- B. Cable will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION**3.1 INSTALLATION OF RACEWAYS AND BOXES**

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
 - 2. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard if entering the room from overhead.
 - 4. Extend conduits 3 inches (75 mm) above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1 and NFPA 70.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C Series of standards.
 - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" .
 - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
 - 4. Cables may not be spliced.
 - 5. 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.
 - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems". Install 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. Do not use heat lamps for heating.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems". Monitor cable pull tensions.
10. Support: Do not allow cables to lie on removable ceiling tiles.
11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271500 "Communications Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

E. 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. Below each feed point, neatly coil a minimum of 72 inches (1830 mm) of cable in a coil not less than 12 inches (305 mm) in diameter.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

3.3 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. 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.
4. Or as required by equipment manufacturers or depicted on the drawings.

3.5 FIRESTOPPING

- A. Comply with requirements in Division 7.
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.6 GROUNDING

- A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Visually inspect UTP cable jacket materials for UL or third-party 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.
 3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after 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.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- 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 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. Dossert; AFL Telecommunications LLC.
 - 3. ERICO International Corporation.
 - 4. Fushi Copperweld Inc.
 - 5. Galvan Industries, Inc.; Electrical Products Division, LLC.
 - 6. Harger Lightning and Grounding.
 - 7. ILSCO.
 - 8. O-Z/Gedney; A Brand of the EGS Electrical Group.
 - 9. Robbins Lightning, Inc.
 - 10. Siemens Power Transmission & Distribution, Inc.

2.2 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 UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel 5/8 by 96 inches (16 by 2400 mm).

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors unless otherwise depicted.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. 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 No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductor's level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods around the 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 No. 2 AWG for taps to equipment grounding terminals.

3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all 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.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.
 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- 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 a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- F. Metallic Fences: Comply with requirements of IEEE C2.
1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
 2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
 3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (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. For grounding electrode system, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 ACTION SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS**2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel or Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. 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.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

- B. Materials: Comply with requirements in Section 05500 "Metal Fabrication" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where it's Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps single-bolt conduit clamps using spring friction action for retention in support channel.
- D. 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 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, [EMT and RMC may be supported by openings through structure members, as permitted in 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 shall 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. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05500 "Metal Fabrication" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (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. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03300 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Section 09900 "Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS**A. Product Data:** For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.**B. LEED Submittals:**

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

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.**1.3 INFORMATIONAL SUBMITTALS****A. Coordination Drawings:** Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS**2.1 METAL CONDUITS, TUBING, AND FITTINGS**

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. ARC: Comply with ANSI C80.5 and UL 6A.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. PVC-Coated Steel Conduit: PVC-coated
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. FMC: Comply with UL 1; zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: Setscrew or compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. ENT: Comply with NEMA TC 13 and UL 1653.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.
- E. Continuous HDPE: Comply with UL 651B.
- F. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- G. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- H. Fittings for LFNC: Comply with UL 514B.
- I. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- J. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 and Type 3R unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
- D. Tele-Power Poles:
 - 1. Material: Galvanized steel with ivory baked-enamel finish
 - 2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.

2. Type: Fully adjustable
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Nonmetallic Floor Boxes: Nonadjustable, round
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).
1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep)
- M. Gangable boxes are prohibited.
- N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 Type 3R Type 4 Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- O. Cabinets:
1. NEMA 250, Type 1 Type 3R Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open] bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- #### A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC Type EPC-80-PVC].
 2. Concealed Conduit, Aboveground: GRC EMT, Type EPC-40-PVC.
 3. Underground Conduit: RNC, Type EPC-40-PVC Type EPC-80-PVC
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
1. Exposed, Not Subject to Physical Damage: EMT or RNC.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Warehouse and storage areas where fork lift may have access
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT or RNC.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 1/2-inch (16-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to Type EPC-40-PVCGRC before rising above floor.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35-mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- O. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
- Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- R. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m).
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

- d. Attics: 135 deg F (75 deg C) temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F (0.06 mm per meter of length of straight run per degree C) of temperature change for PVC conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
 - S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
 - T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
 - U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
 - V. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
 - W. Locate boxes so that cover or plate will not span different building finishes.
 - X. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
 - Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
 - Z. Set metal floor boxes level and flush with finished floor surface.
 - AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- 3.3 INSTALLATION OF UNDERGROUND CONDUIT
- A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Division 2."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2."
4. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ladder cable trays.
2. Single-rail cable trays.

B. Related Requirements:

1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories serving communications systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of cable tray.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports.

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- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.0.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.3 LADDER CABLE TRAYS

- A. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 12 inches (300 mm)] o.c.
3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 4 inches (100 mm) minimum.
8. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
9. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
10. Fitting Minimum Radius: 12 inches (300 mm).
11. Class Designation: Comply with NEMA VE 1, Class 12B.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 SINGLE-RAIL CABLE TRAYS

- A. Description:

1. Configuration: Center rail with extruded-aluminum rungs arranged symmetrically about the center rail.

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2. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
3. Rung Spacing: 12 inches (300 mm) o.c.
4. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
5. Straight Section Lengths: 10 feet (3 m except where shorter lengths are required to facilitate tray assembly.
6. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
7. Support Point: Splice fittings shall be hanger support point.
8. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
9. Loading Depth: 4 inches (100 mm) minimum.
10. Maximum Loads: 50 lb/ft. (74 kg/m).
11. Unbalanced Loads: Maintain cable tray rungs within six degrees of horizontal under all loading conditions.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Hardware and Fasteners: zinc plated according to ASTM B 633.
15. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.

2.5 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Mill galvanized before fabrication.
 - a. Hardware: Galvanized, ASTM B 633 or Chromium-zinc plated, ASTM F 1136.
5. Finish: Electrogalvanized before fabrication.
6. Finish: Hot-dip galvanized after fabrication.
 - a. Hardware: Chromium-zinc plated, ASTM F 1136.
7. Finish: Epoxy-resin or [Powder-coat enamel paint.
 - a. Hardware: Chromium-zinc plated. ASTM F 1136.
8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

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1. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
2. Hardware: Chromium-zinc-plated steel, ASTM F 1136.
3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.6 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: 2-in-3 pitch type made of same materials and with same finishes as cable tray.
- C. Barrier Strips: Same materials and finishes as for cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.7 WARNING SIGNS

- A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA FG 1 .

PART 3 - EXECUTION**3.1 CABLE TRAY INSTALLATION**

- A. Install cable trays according to NEMA FG 1.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Fasten cable tray supports to building structure.

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- D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems.
- E. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- F. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- G. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.
- H. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- I. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- J. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- K. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- L. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

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- D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).
- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

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6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

END OF SECTION 260536

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 07 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS**A. Product Data:** For each type of product.**PART 2 - PRODUCTS****2.1 SLEEVES****A. Wall Sleeves:**

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.**C. Sleeves for Rectangular Openings:**

1. Material: Galvanized sheet steel.

2. Minimum Metal Thickness:

- a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
- b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

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. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

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. Presealed Systems.

2.4 GROUT

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

- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS**2.1 POWER RACEWAY IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
1. Black letters on an orange field.
 2. Legend: Indicate voltage and system or service type.

- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

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

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils (0.1 mm).
3. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
4. 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).

D. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, [continuous-printed on one side with the inscription of the utility,]compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a black background. Minimum letter height shall be 3/8 inch (10 mm). Label shall be screwed or riveted to enclosure.
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 10-foot (3-m) maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Power.
 - 3. UPS.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

- a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Adhesive film label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

SECTION 260583 - ELECTRICAL CONNECTIONS FOR 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. Electrical connections to equipment specified under other Sections or furnished by the Owner.
 - B. Applications of electrical power, control and monitoring connections specified in this section include the following:
 - 1. From electrical source to motor starters.
 - 2. From motor starters to motors.
 - 3. To lighting fixtures and wiring devices.
 - 4. To converters, rectifiers, transformers, inverters, switchgear, switchboards, panel boards, generators and similar equipment.
 - 5. To grounds including ground electrode connections.
 - 6. Equipment furnished in other Divisions (unless indicated otherwise).
 - 7. Electrical connections for equipment, that are not furnished as integral part of equipment, are specified in Division 11 , Division 21 , Division 22, Division 23 , Division 27 , Division 28 and other Division 26 sections, and are criteria of this Section.
 - 8. Refer to Division 23 sections for motor starters and controllers furnished integrally with equipment; not criteria of this Section.
 - 9. Refer to Division 23 sections for control system wiring, not criteria of this section.
 - 10. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division 26 sections, and are criteria of this Section.
 - C. Related requirements:
 - 1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables".
 - D. Alternates: Refer to Division 01 Division 01 "Alternates" for description of Work in this Section affected by Alternates.
-
- 1.3 ACTION SUBMITTALS**
- A. The following data shall be submitted in accordance with Sections 01 "Submittal Procedures" required prior to starting installation:

1. Product Data: Manufacturer's data on electrical connections for equipment products and materials.
 - a. Include data substantiating that materials comply with requirements.
2. Complete wiring diagrams and/or shop drawings for installation purposes shall be furnished under the Mechanical or other Divisions, as required by Project Manager, prior to installation.

1.4 CLOSEOUT SUBMITTALS

- A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Division 01 "Submittal Procedures".

1.5 QUALITY ASSURANCE

- A. Products, materials, equipment and systems shall comply with the following Codes and Standards:
 1. NFPA Compliance: NFPA 70, "National Electrical Code (NEC)" as adopted and amended by the Authority Having Jurisdiction and as applicable to products used and the installation of electrical power connections (terminals and splices), junction boxes, motor starters and disconnect switches.
 2. IEEE Compliance: Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.
 3. ANSI Compliance: Applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.
 4. UL Compliance: UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Electrical connection products and materials are to be UL-listed and labeled.

1.6 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Division 01 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

- A. Products shall be as specified in other Sections of this Division.
- B. General: Each electrical connection shall be a complete assembly of materials,

including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, stress cones, splice kits, termination kits, solder less wire nuts, and other items and accessories as needed to complete splices and terminations as required.

1. Connectors and Terminals: Electrical connectors and terminals shall mate and match, including sizes and ratings, with equipment terminals that are recommended by equipment manufacturer for intended applications.
2. Electrical Connection Accessories: Electrical insulating tape, heat-shrinkable insulating tubing and boots, stress cones, splice kits, termination kits, wirenuts and cable ties as recommended for use by accessories manufacturers for type of services required.

2.2 MECHANICAL AND ELECTRICAL COORDINATION

- A. Responsibility: Division 01 The Contractor shall include all costs and work associated with these items in his bid.
- B. Verify location, size, and characteristics of all mechanical equipment before installation of electric service. In all cases of the installation of heating, ventilating, air conditioning, plumbing, and other mechanical equipment, the Contractor is responsible for all revisions, changes, and modifications necessary to properly supply electric services to the equipment.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 PREPARATION

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.3 INSTALLATION

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
- B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit in damp or wet locations. Length shall be six feet (6') maximum.
- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, use attachment plug with suitable strain-relief clamps.

- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring as required for a complete operating system.
- F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as required for a complete operating system. Connect with conduit and wiring as required for a complete operating system.

3.4 EQUIPMENT CONNECTION SCHEDULE

- A. Furnish, set in place, and wire, except as may be otherwise indicated, all heating, ventilating, air conditioning, plumbing, fire protection, and other motors and controls in accordance with the electrical/mechanical coordination schedule. The contractor shall carefully coordinate with work performed under the Mechanical and other Divisions if these specifications.
- B. All line and low voltage wiring shall be installed utilizing materials and methods as specified in the Division 26 of the technical specifications.
- C. Provide NEMA-rated motors and equipment suitable for operation on the voltage systems as designated below, with tolerances for the allowable voltage variations above and below the nominal:

1. Rated Motor Voltage:

Service Voltage and Phase:	1/3 HP and smaller 1-Phase:	1/2 HP and Larger 3-Phase:
120/208V, 3-Phase	115V	208V (only when 480V is not available)
277/480V, 3-Phase		460V

3.5 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Electrical connections shall be installed in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
 - 1. As a minimum: Each feeder circuit to panelboards, switchboards, motor control centers, transformers, and 480-volt (and higher) motor circuits shall have an insulated equipment ground conductor.
 - 2. All medium voltage splices and terminations are to be made by a certified cable splicer/terminator.
 - 3. Electrical service and feeders are to be maintained to occupied areas and operational facilities when temporary service is required during interruptions to existing facilities. Momentary outages for replacing existing wiring systems with

new wiring systems shall be scheduled. When the "cutting-over" has been successfully accomplished, temporary wiring is to be removed.

4. Splices shall be covered with electrical insulating material equivalent to, or of greater insulation rating, than electrical insulation rating of those conductors being spliced.
5. Cables and wires shall be trimmed as long as practicable and routing shall be arranged to facilitate inspection, testing, and maintenance.
6. Connectors and terminals, including screws and bolts, shall be tightened in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings shall be used to comply with torquing values contained in UL 496A or the manufacturer's literature.
7. Identification markers are to be fastened to each electrical power supply wire/cable conductor in accordance with Section 260553 "Identification for Electrical Systems".
 - a. Markers are to be affixed on each terminal conductor, as close as possible to the point of connection.

3.6 FIELD QUALITY CONTROL

- A. The correct direction of rotation of each motor is to be verified.
- B. Provide measured torquing value checklist with witness signature to Project Manager.
- C. Perform infrared scanning of all splices and terminations as required in Section 260519 "Low-Voltage Electric Power Conductors and Cables".

PART 4 - MEASUREMENT

4.1 MEASUREMENT

- A. No separate measurement will be made for the work specified in this Section.

PART 5 - PAYMENT

5.1 PAYMENT

- A. No separate payment will be made for work specified in this Section, but shall be included in the Contract Lump Sum Bid Price for Division 26 - Electrical, which price shall include all necessary and incidental material and work thereto.

END OF SECTION 260583

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SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy sensors.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data

PART 2 - PRODUCTS

2.1 TIME SWITCHES

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

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Mfg. Company Inc.
5. NSi Industries LLC; TORK Products.
6. Tyco Electronics; ALR Brand.

- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Contact Configuration: SPST.
 - 3. Contact Rating: 30-A inductive or resistive, 277-V ac.
 - 4. Programs: Eight on-off set points on a 24-hour schedule.
 - 5. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
 - 6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 - 7. Astronomic Time: All channels.
 - 8. Automatic daylight savings time changeover.
- C. Electromechanical-Dial Time Switches: Comply with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Contact Configuration: SPST .
 - 3. Contact Rating: 30-A inductive or resistive, 277-V ac.
 - 4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
 - 5. Astronomic time dial.
 - 6. Eight-Day Program: Uniquely programmable for each weekday and holidays.
 - 7. Skip-a-day mode.
 - 8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Industries, Inc.
 - 2. Intermatic, Inc.
 - 3. NSi Industries LLC; TORK Products.
 - 4. Tyco Electronics; ALR Brand.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
 - 3. Time Delay: Thirty-second minimum, to prevent false operation.
 - 4. Lightning Arrester: Air-gap type.
 - 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, products by one of the following:
1. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC; TORK Products.
 9. RAB Lighting.
 10. Sensor Switch, Inc.
 11. Square D; a brand of Schneider Electric.
 12. Watt Stopper.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).

2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
1. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.

7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products.
9. RAB Lighting.
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric.
12. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent or as depicted on the drawings

2.5 LIGHTING CONTACTORS

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

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Corporation.
4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
5. Square D; a brand of Schneider Electric.

B. Description: Electrically operated and electrically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
- C. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.
- D. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- E. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Perform the following 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. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 260923

SECTION 260943.23 - RELAY-BASED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes lighting control panels using mechanically held relays for switching.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each relay panel and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail wiring partition configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of relays.
 - 5. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.
- B. Field quality-control reports.
- C. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panels for installation according to NECA 407.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control panels. Any combination of inputs shall be programmable to any number of control relays.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 916.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Lighting control panels shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.0.

2.3 LIGHTING CONTROL RELAY PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - 1. Acuity Brands, Inc.; Lighting Control & Design, Inc.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Leviton Mfg. Company Inc.
 - 4. Lightolier Controls; a Philips Group brand.
 - 5. Siemens Energy & Automation, Inc.
 - 6. Touch-Plate Technologies.
 - 7. WattStopper; a Legrand Group brand.
 - 8.
- B. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.
- C. Lighting Control Panel:
 - 1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
 - 2. A vertical barrier separating branch circuits from control wiring.

- D. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.
1. Timing Unit:
 - a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
 - b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
 - c. Four independent schedules, each having 24 time periods.
 - d. Schedule periods settable to the minute.
 - e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
 - f. 10 special date periods.
 2. Sequencing Control with Override:
 - a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
 - b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
 - d. Override control "blink warning" shall warn occupants approximately five minutes before actuating the off sequence.
 3. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation, including accurate time of day and date.
- E. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. Control shall be three-wire, 24-V ac.
- F. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120-V tungsten, 30 A at 277-V ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be three-wire, 24-V ac.
- G. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and photo sensors.
- H. Operator Interface:
1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
 2. Log and display relay on-time.
 3. Connect relays to one or more time and sequencing schemes.

2.4 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.
 - 1. Match color and style specified in Section 262726 "Wiring Devices."
 - 2. Integral green LED pilot light to indicate when circuit is on.
 - 3. Internal white LED locator light to illuminate when circuit is off.
- B. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."
- C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.5 FIELD-MOUNTED SIGNAL SOURCES

- A. Indoor Occupancy Sensors: Comply with Section 260923 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panels according to NECA 407.
- B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
 - 3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 PANEL INSTALLATION

- A. Comply with NECA 1.
- B. Install panels and accessories according to NECA 407.
- C. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- D. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- E. Mount panel cabinet plumb and rigid without distortion of box.
- F. Install filler plates in unused spaces.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

- C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.
- D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Acceptance Testing Preparation:
 - 1. Test continuity of each circuit.
- D. Lighting control panel will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.7 ADJUSTING

- A. 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.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 260943.23

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SECTION 262200 - LOW-VOLTAGE TRANSFORMERS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
 - 1. Include data substantiating that materials comply with requirements.
- 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. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means, "The unit will remain in place without separation of any parts from the device when subjected to the seismic

forces specified and the unit will be fully operational after the seismic event."

2. 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. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.
- B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. 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.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- B. Handle using only lift eyes and provided brackets. Protect equipment in inclement weather.

1.8 COORDINATION

- A. For floor-mounted transformers, 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.
- B. For wall-mounted and structure-mounted transformers, coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.9 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Match existing equipment in the vicinity, if applicable. Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 2. General Electric Company.
 - 3. Square D; Schneider Electric.
 - 4. or approved equal.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material:
 - 3. Transformers rated up to 45kVA: Copper or Aluminum.
 - a. Transformers rated above 45kVA: Copper windings are required.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.

- C. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- E. Taps for Transformers Smaller than 3 kVA: None.
- F. Taps for Transformers 7.5 to 24 kVA: "One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.
- J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- K. Electrostatic Shielding: Each winding shall have an 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 the shield.
 - 3. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91. Maximum sound levels

shall be as follows:

1. 1 to 5 kVA: 37dB.
2. 6 to 25 kVA: 42dB.
3. 26 to 150 kVA: 47dB.
4. 151 to 225 kVA: 52dB.
5. 226 to 300 kVA: 52dB.
6. 301 to 500 kVA: 57dB.

2.4 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 1. Finish Color: Gray.

2.5 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each **distribution** and **buck-boost** transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
 1. Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written 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 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall 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. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on a 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-mounting transformers according to manufacturer's written instructions, **seismic codes applicable to Project**, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.

- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform two (2) follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
 - 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each 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 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a 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.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Identification.

1.2 PERFORMANCE REQUIREMENTS

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
3. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 2.
- C. Comply with NFPA 70.
- D. Comply with UL 891.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

- B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Panel mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

- C. Nominal System Voltage: 480Y/277 V

- D. Main-Bus Continuous: 1500 A.

- E. Enclosure: Steel, NEMA 250, Type 3R.

1. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.

- F. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

- G. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

- H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

- I. Phase and Neutral Buses and Connections: Three phase, four wire unless otherwise indicated. Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
 - 1. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) minimum size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.
 - 2. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 3. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.
- J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
 - 1. Fuses, rated at 200-kA interrupting capacity.
 - 2. LED indicator lights for power and protection status.
 - 3. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device.
 - 5. Transient-event counter set to totalize transient surges.
- B. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
- C. Withstand Capabilities: 5000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- D. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277-V, three-phase, four-wire circuits shall be as follows:
 - 1. Line to Neutral: 800 V for 480Y/277.
 - 2. Line to Ground: 800 V for 480Y/277.
 - 3. Neutral to Ground: 800 V for 480Y/277.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - g. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
 1. Fixed circuit-breaker mounting.
 2. Two-step, stored-energy closing.
 3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 5. Remote trip indication and control.
 6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."

7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. Pringle Electrical Manufacturing Company, Inc.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D; a brand of Schneider Electric.
 2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
 - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
 - b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
 3. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
 4. Service-Rated Switches: Labeled for use as service equipment.
 5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
 - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

2.4 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install switchboards and accessories according to NECA 400.

- B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 03300 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Install spare-fuse cabinet.
- H. Comply with NECA 1.
- I. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- J. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate

complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Switchboard will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262413

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SECTION 262416 - PANELBOARDS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Panelboard schedules for installation in panelboards.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.

- C. Comply with NFPA 70.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Wash-Down Areas: NEMA 250, Type 4X.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses: Tin-plated aluminum.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated aluminum
 - 2. Main and Neutral Lugs: Compression type.
 - 3. Ground Lugs and Bus Configured Terminators: Compression type.
 - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

- G. symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type. All panelboards shall be from the same manufacturer.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

- F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

- e. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
 - h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
- 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Torque all connections per manufacturer's requirements.
- E. Install filler plates in unused spaces.
- F. Stub two 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub two 1-inch empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

- H. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.
6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 GFCI RECEPTACLES

- A. General Description:
1. Straight blade, non-feed-through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

- 1) Single Pole:
 - 2) Cooper; AH1221.
 - 3) Hubbell; HBL1221.
 - 4) Leviton; 1221-2.
 - 5) Pass & Seymour; CSB20AC1.
- 6) Two Pole:
 - 7) Cooper; AH1222.
 - 8) Hubbell; HBL1222.
 - 9) Leviton; 1222-2.
 - 10) Pass & Seymour; CSB20AC2.
- 11) Three Way:
 - 12) Cooper; AH1223.
 - 13) Hubbell; HBL1223.
 - 14) Leviton; 1223-2.
 - 15) Pass & Seymour; CSB20AC3.
- 16)
- 17) Four Way:
 - 18) Cooper; AH1224.
 - 19) Hubbell; HBL1224.
 - 20) Leviton; 1224-2.
 - 21) Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; AH1221PL for 120 and 277 V.

- b. Hubbell; HBL1201PL for 120 and 277 V.
 - c. Leviton; 1221-LH1.
 - d. Pass & Seymour; PS20AC1RPL for 120 V, PS20AC1RPL7 for 277 V.
- 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."

D. Key-Operated Switches, 120/277 V, 20 A:

- 1. Products: Subject to compliance with requirements, provide the following:
 - a. Cooper; AH1221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
- 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6252.
 - b. Hubbell; DR15.
 - c. Leviton; 16252.
 - d. Pass & Seymour; 26252.

B. GFCI, Non-Feed-Through Type, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF15.
 - b. Hubbell; GF15LA.
 - c. Leviton; 8599.
 - d. Pass & Seymour; 1594.

C. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 7621 (single pole), 7623 (three way).
 - b. Hubbell; DS115 (single pole), DS315 (three way).
 - c. Leviton; 56291-2 (single pole), 5623-2 (three way).

- d. Pass & Seymour; 2621 (single pole), 2623 (three way).
- D. Lighted Toggle Switches, Square Face, 120 V, 15 A: Comply with NEMA WD 1 and UL 20.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 7631 (single pole), 7633 (three way).
 - b. Hubbell; DS120IL (single pole), DS320 (three way).
 - c. Leviton; 5631-2 (single pole), 5633-2 (three way).
 - d. Pass & Seymour; 2625 (single pole), 2626 (three way).
 - 2. Description: With neon-lighted handle, illuminated when switch is "off."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.**G. Dimmers:**

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.**I. Adjust locations of service poles to suit arrangement of partitions and furnishings.****3.2 GFCI RECEPTACLES**

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

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SECTION 262813 - FUSES

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 SECTION INCLUDES

- A. Fuses.

1.3 REFERENCES

- A. NFPA 70 - National Electric Code.
- B. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.4 SUBMITTALS

- A. Submit under provisions of Section 260500.
- B. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 260500.
- B. Record actual fuse sizes.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years' experience.

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.

- B. Furnish products listed and classified by UL and referenced standards as suitable for purpose specified and indicated.

1.8 EXTRA MATERIALS

- A. Provide three of each size and type fuse installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Bussman.
 - 2. Littelfuse.
 - 3. Ferraz-Shawmut.
 - 4. Substitutions: Under provisions of Division 1.

2.2 FUSE REQUIREMENTS

- A. Service Entrance: Class L, fast acting or as depicted on the drawings.
- B. Feeders: Class L, fast acting or as depicted on the drawings.
- C. Motor Branch Circuits: Class RK1 time delay or as depicted on the drawings.
- D. Other Branch Circuits: Class J, fast acting or as depicted on the drawings.
- E. Control Circuits: Class CC, fast acting or as depicted on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in accordance with manufacturer's instructions.
- B. Install fuse with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES

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 SECTION INCLUDES

- A. Fusible Switches
- B. Nonfusible Switches

1.3 RELATED SECTIONS

- A. Section 262813- Fuses.

1.4 REFERENCES

- A. NECA - Standard of Installation (published by the National Electrical Contractors Association).
- B. NEMA FU1 - Low Voltage Cartridge Fuses.
- C. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (published by the International Electrical Testing Association).
- E. NFPA 70 - National Electrical Code.

1.5 SUBMITTALS FOR REVIEW

- A. Section 260400: Procedures for submittals.
- B. Product Data: Provide switch ratings and enclosure dimensions.

1.6 SUBMITTALS FOR CLOSEOUT

- A. Record actual locations of enclosed switches in project record documents.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers
 - 1. Square-D
 - 2. Eaton Corporation
 - 3. General Electric
 - 4. Siemens
 - 5. Substitutions: Under provisions of Section 260500.

2.2 FUSIBLE SWITCH ASSEMBLIES

- A. Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.
- B. Fuse Clips: Designed to accommodate NEMA FU1, Class R fuses.

2.3 NONFUSIBLE SWITCH ASSEMBLIES

- A. Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.

2.4 ENCLOSURES

- A. Fabrication: NEMA KS 1.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation".
- B. Install fuses in fusible disconnect switches.
- C. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 262816

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SECTION 265100 - INTERIOR LIGHTING**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- C. Samples: Provide samples of manufacturer's finishes for color selection.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- 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. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.

2.3 LED SOURCES

- A. Comply with ANSI/UL 1993 AND ANSI/UL 8750, "Light Emitting Diode (LED) for Use in Lighting Products". Photometric testing data shall be in accordance with IESNA LM-79. Lumen maintenance depreciation measurements shall be in accordance with IESNA LM-80, while long term lumen maintenance estimations shall be in accordance with IESNA TM-21
- B. LED sources shall have a color temperature of 3500K and a minimum CRI of 80, with an R9 value of >50
- C. LED sources shall start and operate in 0°F to 40°F ambient.

- D. LED sources shall be designed for ease of component replacement and end-of-life disassembly from room side. All internal components shall be assembled and pre-wired using modular electrical connections.
- E. LED sources shall be RoHS compliant (Restriction of Hazardous Substances).
- F. LED sources shall be binned to a 3 step MacAdam ellipse (SDCM: Standard Deviation Color Matching) of the 3500K (or as depicted in the lighting schedule) Planckian Locus to ensure color consistency.
- G. LED products must have a minimum 5 year warranty for replacement of all components, including LED board or driver:

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
 - 2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 - 3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.5 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When

normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15minutes when power is restored after an outage.

2.6 LED Luminaires

- A. Install manufacturer depicted on the drawings or approved equal.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.
- E. Adjust aimable lighting fixtures to provide required light intensities.
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

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SECTION 265600 - EXTERIOR LIGHTING**PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.

1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.
- C. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
- D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
 1. Basic wind speed for calculating wind load for poles exceeding 49.2 feet (15 m) in height is 90 mph (40 m/s)
 - a. Wind Importance Factor: 1.0.
 - b. Minimum Design Life: 50 years
 - c. Velocity Conversion Factors: 1.0
 2. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 90 mph (40 m/s)
 - a. Wind Importance Factor: 1.0.
 - b. Minimum Design Life: 25 years.
 - c. Velocity Conversion Factors: 1.0.

1.3 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

- C. Samples: Provide samples of manufacturer's finishes for color selection

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2, "National Electrical Safety Code."
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
 - 1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
 - 2. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. 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. Designed to disconnect ballast when door opens.

- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. 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.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. 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.
- M. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.
- N. 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.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - a. Color: As shown in the schedule.
- O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. 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 and ballast characteristics:
 - a. "USES ONLY" and include specific lamp type.
 - b. Lamp tube configuration (twin, quad, triple), base type, and nominal wattage for compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start) compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.

2.3 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.
 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
 2. Adjustable window slide for adjusting on-off set points.

2.4 LED Luminaires

- A. Ingress protection shall comply with IP 66.
- B. Luminaire's minimum vibration resistance conforms to ANSIC136.31 for 3G vibration for normal applications.
- C. Luminaire electrical characteristics.
 1. Voltage fluctuation tolerances $\pm 10\%$.
 2. Total harmonic distortion $\leq 20\%$.
 3. Power factor ≥ 0.9 .
 4. Operating temperature -40°C to $+40^{\circ}\text{C}$.
 5. Blue light compliant with EN 62471.
- D. Luminaire LED performance
 1. Minimum luminaire efficacy of 100 lumens/watt.
 2. Correlated Color Temperature (CCT) between 3,500 –4,500 unless exception is specified.
 3. Minimum Coloring Rendering Index (CRI) is 80.

4. Up-light control complies with MLO BUG rating.
5. Minimum LLD of .85 at 100,00 hours at 25°C ambient.

E. Luminaire Photometry

1. Luminaire shall meet IES RP-8 values for location parameters.
2. Luminaire test results in accordance with IESNA LM-79.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 03300 "Cast-in-Place Concrete."

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.6 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
 - 1. Shape: Square, straight.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
 - 1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
 - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 - 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.
- F. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- H. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- I. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
 - 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As scheduled, final colors to be selected by architect from manufacturer's full range.

2.7 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
 1. Shape: Square, straight.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 2. Finish: Same as pole.
- F. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - a. Color: As scheduled, final colors to be selected by architect from manufacturer's full range.

2.8 POLE ACCESSORIES

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

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03300 "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 2. Install base covers unless otherwise indicated.
 - 3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 - 1. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augured holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
 2. Fill augured hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.
 3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03300 "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03300 "Cast-in-Place Concrete."

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 260533 "Raceways and Boxes 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 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole unless otherwise indicated.
 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Install grounding conductor and conductor protector.
 2. Ground metallic components of pole accessories and foundations.

END OF SECTION 265600

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ladder cable trays.
2. Wire-basket cable trays.

B. Related Requirements:

1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of cable tray.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.0.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.3 LADDER CABLE TRAYS

- A. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 12 inches (300 mm) o.c.
3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 4 inches (100 mm).
8. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
9. Width: 12 inches (300 mm).
10. Fitting Minimum Radius: 12 inches (300 mm).
11. Class Designation: Comply with NEMA VE 1, Class 12B.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 WIRE-BASKET CABLE TRAYS

- A. Description:

1. Configuration: Wires are formed into a standard 2-by-4-inch (50-by-100-mm) wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
2. Materials: High-strength-steel longitudinal wires with no bends.

3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch (3000-mm) lengths.
 - b. Wire-Basket Depth: 4-inch (100-mm) usable loading depth by 12 inches (300 mm) wide.
5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

2.5 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Mill galvanized before fabrication.
 - a. Hardware: Galvanized, ASTM B 633 or Chromium-zinc plated, ASTM F 1136.
5. Finish: Electrogalvanized before fabrication.
6. Finish: Hot-dip galvanized after fabrication.
 - a. Hardware: Chromium-zinc plated.
7. Finish: Epoxy-resin or Powder-coat enamel paint.
 - a. Hardware: Chromium-zinc plated, ASTM F 1136.
8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

B. Aluminum:

1. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
2. Hardware: Chromium-zinc-plated steel.

3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

C. Stainless Steel:

1. Materials: Low-carbon, passivated, stainless steel, Type 304L or Type 316L, ASTM F 593 and ASTM F 594.
2. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.6 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: 2-in-3 pitch type made of same materials and with same finishes as cable tray.
- C. Barrier Strips: Same materials and finishes as for cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.7 WARNING SIGNS

- A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA FG 1.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Fasten cable tray supports to building structure.

- D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- E. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- F. Support wire-basket cable trays with trapeze hangers
- G. Support trapeze hangers for wire-basket trays with 1/4-inch- (6-mm-) diameter rods.
- H. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- I. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.
- J. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- K. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- L. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- M. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- N. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).
- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorquing in suspect areas.
 - 7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

- B. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed cable trays and cables.

END OF SECTION 270536

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SECTION 283100 – FIRE DETECTION AND ALARM PERFORMANCE SPECIFICATION**1. Fire Alarm System design****1.1. The requirements of Fire Alarm System selection and design of the Fire Alarm System:****1.1.1. To be performed only by a Professional Engineer registered in the State of Colorado.****1.1.1.1. The Professional Engineering sealing the design plans shall be responsible for the design of the entire system.****1.1.2. Professional Engineer shall carry errors and omissions insurance in the amount of \$1 million per occurrence, \$2 million aggregate, and shall submit evidence of coverage with quote.****1.1.3. The design phase shall include the Fire Alarm System selection and all information required to complete the project.****1.1.3.1. The design shall include the area of the Fire Alarm System in square feet to assist in the preparation of an estimate of the cost of construction.****1.1.4. The design documents shall have a Fire Alarm System plan that identifies all elements of the Fire Alarm System and details consistent with best practices as determined by recognized industry standards, of a Nationally Recognized Testing Laboratory, NFPA, IBC, and IFC.****1.1.5. Professional Registrant shall mark all submittals in a way that it is easily recognized as the “reviewed submittal” and shall direct the contractor to keep the “reviewed submittal” on site and accessible at all times during the duration of the project. Marking shall be substantially similar to the sample at the end of this section.****1.1.6. Nationally Recognized Testing Laboratory and NFPA standards and specifications shall be used.****1.1.7. The Professional Engineer shall determine substantial equivalency of submissions for prior approval and substitutions.**

1.2. Construction Administration

- 1.2.1. The Professional Registrant must perform construction administration to ensure construction is in compliance with the design intent of the drawings and specifications, which will require at least a weekly site visit to ensure conformance of material installation with the design intent of the plans.

1.3. Commissioning

- 1.3.1. At the completion of the project the system shall be commissioned in accordance with current edition of NFPA 3, Standard for Commissioning Fire Protection and Life Safety Systems. And the current edition of NFPA 4 Standard for Integral Fire Protection and Life Safety Testing. Together with the current edition of NFPA 72.
- 1.3.2. At the completion of the installation, the Professional Engineer shall be in attendance for the final acceptance tests with the Fire Marshal.
- 1.3.3. If the installed system is required to shut down any air handlers, the Project Manager shall contract with an independent Mechanical Engineer to carry Air Handling shut down certifications and provide copies to the Fire Marshal.

1.4. Design schedule

- 1.4.1. Professional Engineer to submit the schedule of completion within 5 business days of receiving notice to proceed on the design contract.

2. Fire Alarm System construction

- 2.1.1 Fire Alarm System to be constructed per plans and specifications by a qualified Licensed Colorado contractor who must comply with all Colorado regulations, building regulations, rules, laws, codes, and ordinances.
- 2.1.2 The proposed Systems shall be installed by a currently Authorized, Trained and Certified Engineered systems distributor of the product to be installed with a minimum of 5 years of experience and Licensed in the State of Colorado.

- 2.1.3 The proposed Manufacturer must have a minimum of 2 Authorized, Trained and Certified, Engineered Systems Distributors of the product to be used.
- 2.1.4 All Fire Alarm systems on the same site must be of the same manufacturer and communicate with each other through the manufacturers listed communications protocol as one complete system.
- 2.1.5 The expected life span of the installed equipment shall be a minimum of 10 years from the completion of the installation.
- 2.1.6 All parts used for the installation or repair of the installed system shall be New and purchased direct from the manufacturer with full warranty.
- 2.1.7 No parts shall be purchased, supplied or installed in any manner from any online source or source other than the authorized engineered systems distributor of the product being used.
- 2.1.8 The contract documents and reviewed submittals shall be on site and accessible at all times.
- 2.1.9 Contractor shall submit a Sample Warranty Certificate at the time of the request for prior approval or substitution.
- 2.1.10 Contractor shall carry liability insurance in the amount of \$2 million per occurrence, \$5 million aggregate, and shall submit evidence of coverage with their quote.
- 2.1.11 Contractor shall carry umbrella liability insurance in the amount of \$5 million per occurrence, and shall submit evidence of coverage with their quote.
- 2.1.12 Contractor shall carry performance and payments bonds for all projects that are \$100,000 or more in construction costs.
- 2.1.13 Bid bonds are required on all bid / quote for projects that are \$100,000 or more in construction costs.
- 2.1.14 The contractor shall submit a schedule of completion within 5

business days of receiving the notice to proceed on the construction contract.

3. These specifications shall be used for any and all Fire Alarm related systems in this project. The applicable specification sections shall be determined as follows:
4. All vendors are responsible to comply with all regulations, rules, laws, codes, and ordinances while performing any aspect of the project.
5. New system installation requirements
 - 5.1. The installing contractor must be certified / approved by manufacturer of the system being installed and must have a minimum of five (5) years of experience installing a similar system.
 - 5.1.1. Certification(s) for all potential Fire Alarm Systems (including prior approvals) shall be included in the bid / quote documents that are submitted. This section shall also apply if substitutions are being made after the award of any Fire Alarm System project.
 - 5.2. The Fire Alarm System shall be designed and installed to provide sustained performance for a minimum of 10 years.
 - 5.2.1. The manufacturers Currently Authorized Distributor shall submit an "Intent to Warrant" document and that document shall be included in the bid / quote submission.
 - 5.3. All Fire Alarm System mounted equipment and accessories have to meet the Fire Alarm System manufacturer's requirements for clearance, heights, etc.
6. Manufacturers shall not be cited in the specifications. All Nationally Recognized Testing Laboratory Listed, Engineered Networked Fire Alarm voice evacuation system, meeting the requirements of the Fire Alarm Specifications for the project and complying with the characteristics of the performance specification will be accepted.
7. Warranty

- 7.1. All Fire Alarm Systems shall have at least a 2-year, no dollar limit (NDL), labor and material manufacturer product warranty. Manufacturers Currently Authorized Distributor agrees to repair or replace components of the Fire Alarm System that fail in materials or workmanship within specified warranty period.
 - 7.1.1. The Fire Alarm System manufacturers Currently Authorized Distributor shall certify that the installation is compliant with all manufacturer requirements upon issuance of the warranty.
- 7.2. The installing contractor shall provide a minimum 2-year materials and labor warranty for the complete installation.
- 7.3. Discrepancies in the Documents Prioritization for resolving discrepancies in the contract documents are resolved as follows:
 1. Specifications
 2. Dimensions
 3. Notations
 4. Drawings
- 7.4. In the event of discrepancies within the specifications, the most stringent requirement shall apply.
8. Substantial Completion
 - 8.1. The Architect shall issue a Substantial Completion Form to establish the start date of the warranty period. This form may be the American Institute of Architects (AIA) form, or another equal.
9. Closeout Documents
 - 9.1. The closeout documents must be submitted in an electronic (".pdf" format) with one bound hard copy to the Architect and shall include at least the following:
 - 9.1.1 A complete set of "as-built" documents describing location of all installed items and elements.
 - 9.1.1.1 The contractor shall track all modifications to the original design and record those modifications in the record drawings for

the project. The contractor shall provide those record drawings that include a complete and accurate description of work done that deviates from the requirements of the contract documents and the exact locations of all concealed work to the Professional Registrant at project completion.

9.1.1.2 The as-built drawings shall be provided in the form of hard copy and an electronic “pdf” format to the Architect as part of the close out documentation.

9.1.2 The warranty signed by the Installing Currently Authorized Distributor with the start date of the warranty. The written field records of all inspections, testing, construction administration and quality assurance / quality control site visits conducted during the installation of the system.

9.1.3 An “AS BUILT DOCUMENT” Cabinet shall be supplied and installed by the Main Fire Alarm Control Cabinet, or another location acceptable to the Fire Marshal. If the Fire Alarm AS BUILT cabinet is not in the same location as the fire alarm control panels, its location shall be identified at the FACP. The cabinet shall contain a copy of the latest Stamped “AS BUILT” drawings for the project including the systems Operating and Maintenance manuals. In accordance with NFPA 72, a copy of the installed program on a USB drive permanently affixed to the cabinet shall also be included. The Cabinet should contain a tamper switch connected to the fire alarm system panel to generate a trouble/supervisory signal if the cabinet is opened.

END OF SECTION 283100