Milwaukee County
Department of Administrative Services
Facilities Management Division

Milwaukee County Zoological Gardens
Adventure Africa Elephant Exhibit

Volume 2
100 % Construction Documents Project Manual
February 6, 2017

Architecture | Engineering | Planning

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HGA Commission No. 1215-015-00

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SECTION SLEEVES AND SLEEVE SEALS FOR FIRE SUPPRESSION PIPING 210517

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

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

1. Smith, Jay R. Mfg. Co.
2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Metraflex Company (The).
2. Pipeline Seal and Insulator, Inc.
3. Proco Products, Inc.

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

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

1. Presealed Systems.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION

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

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078400 " Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

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

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a) Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves.
      b) Piping NPS 6 (DN 150) and Larger: Galvanized-steel wall sleeves.
   2. Exterior Concrete Walls below Grade:
      a) Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
      b) Piping NPS 6 (DN 150) and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a) Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
      b) Piping NPS 6 (DN 150) and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   4. Interior Partitions:
      a) Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
      b) Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION ESCUTCHEONS FOR FIRE SUPPRESSION PIPING
210518

PART 1 GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

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

PART 2 PRODUCTS

2.1 ESCUTCHEONS

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

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

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

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      c) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
      d) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      e) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
      f) Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
      g) Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.

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

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT 210553

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe labels.
   2. Valve tags.

PART 2 PRODUCTS

2.1 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.

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

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

D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

E. Pipe-Label Colors:
   1. Background Color: Red.
   2. Letter Color: White.

2.2 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping-system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Brass, 0.032 inch (0.8 mm) (0.64 mm) (0.8 mm) or anodized aluminum, 0.032 inch (0.8 mm) thick, with predrilled holes for attachment hardware.
   2. Fasteners: Brass wire-link chain or S-hook.
   3. Valve-Tag Color: Red.
   4. Letter Color: White.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 LABEL INSTALLATION

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

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

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems. List tagged valves in a valve-tag schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
   1. Valve-Tag Size and Shape:
      a) Fire-Suppression Standpipe: 1-1/2 inches (38 mm) (50 mm), round.
      b) Wet-Pipe Sprinkler System: 1-1/2 inches (38 mm) (50 mm), round.

END OF SECTION

SECTION WET PIPE SPRINKLER SYSTEMS
211313

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Pressure gages.

1.2 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.3 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.4 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:
   a) Building Service Areas: Ordinary Hazard, Group 1.
   b) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   c) General Storage Areas: [Ordinary Hazard, Group 1] <Insert classification>.
   d) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   e) Office and Public Areas: Light Hazard.
3. Minimum Density for Automatic-Sprinkler Piping Design:
   a) Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
   b) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Maximum Protection Area per Sprinkler:
   a) Office Spaces: 120 sq. ft. (11.1 sq. m) (20.9 sq. m).
   b) Storage Areas: 130 sq. ft. (12.1 sq. m).
   c) Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
   d) Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
   e) Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

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

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Domestic water piping.
   2. HVAC hydronic piping.
   3. Items penetrating finished ceiling include the following:
      a) Lighting fixtures.
      b) Air outlets and inlets.

E. Qualification Data: For qualified Installer and professional engineer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

G. Welding certificates.

H. Fire-hydrant flow test report.

I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

J. Field quality-control reports.

K. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a) Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

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

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.7 PROJECT CONDITIONS

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

1.8 COORDINATION

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

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

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

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Uncoated, Steel Couplings: ASTM A 865, threaded.

E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Pressure Rating: 175 psig (1200 kPa) (1725 kPa) (2070 kPa) minimum.
   2. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
   3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

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

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

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

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed or FM approved.
   2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).

B. Ball Valves:
   1. Standard: UL 1091 except with ball instead of disc.
   2. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
   3. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
   4. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:
   1. Standard: UL 1091.
   2. Pressure Rating: 175 psig (1200 kPa).
   3. Body Material: Bronze.
   4. End Connections: Threaded.

D. Iron Butterfly Valves:
   1. Standard: UL 1091.
   2. Pressure Rating: 175 psig (1200 kPa).
   3. Body Material: Cast or ductile iron.
   4. Style: Lug or wafer.
   5. End Connections: Grooved.

E. Check Valves:
   1. Standard: UL 312.
   2. Pressure Rating: 250 psig (1725 kPa) minimum (2070 kPa).
   3. Type: Swing check.
   4. Body Material: Cast iron.
   5. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:
   1. Standard: UL 262.
   2. Pressure Rating: 175 psig (1200 kPa).
   3. Body Material: Bronze.
   4. End Connections: Threaded.

G. Iron OS&Y Gate Valves:
   1. Standard: UL 262.
   2. Pressure Rating: 250 psig (1725 kPa) minimum (2070 kPa).
   3. Body Material: Cast or ductile iron.
   4. End Connections: Flanged or grooved.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:
   1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2. Pressure Rating: 175 psig (1200 kPa) minimum.

2.6 SPECIALTY VALVES

A. General Requirements:
   1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2. Pressure Rating:

a) Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
b) High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum (2070 kPa).
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

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

2.7 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:
1. Standard: UL 405.
2. Type: Exposed, projecting, for wall mounting.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Round, brass, wall type.
8. Outlet: Back, with pipe threads.
9. Number of Inlets: Two.
10. Escutcheon Plate Marking: Similar to "AUTO SPKR."
11. Finish: [Polished chrome plated] [Rough brass or bronze] [Rough chrome plated].
12. Outlet Size: NPS 4 (DN 100) (DN 125) (DN 150).

2.8 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:
1. Standard: UL 213.
2. Pressure Rating: 175 psig (1200 kPa) minimum (2070 kPa).
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum (2070 kPa).
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

C. Branch Line Testers:
1. Standard: UL 199.
2. Pressure Rating: 175 psig (1200 kPa).
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
   1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2. Pressure Rating: 175 psig (1200 kPa) minimum (2070 kPa).
   3. Body Material: Cast- or ductile-iron housing with sight glass.
   4. Size: Same as connected piping.
   5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
   1. Standard: UL 1474.
   2. Pressure Rating: 250 psig (1725 kPa) minimum (2070 kPa).
   3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
   4. Size: Same as connected piping.
   5. Length: Adjustable.
   6. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:
   1. Standard: UL 1474.
   2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
   3. Pressure Rating: 175 psig (1200 kPa) minimum (2070 kPa).
   4. Size: Same as connected piping, for sprinkler.

2.9 SPRINKLERS

A. General Requirements:
   1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
   3. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.

B. Automatic Sprinklers with Heat-Responsive Element:
   1. Early-Suppression, Fast-Response Applications: UL 1767.
   2. Nonresidential Applications: UL 199.
   3. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

C. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
   1. Characteristics:
      a) Nominal 1/2-inch (12.7-mm) Orifice: With Discharge Coefficient K between 5.3 and 5.8.

D. Sprinkler Finishes:
   1. Chrome plated.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: (25-mm)Plastic, white finish, one piece, flat.
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.
   1. Standard: UL 753.
   2. Type: Mechanically operated, with Pelton wheel.
   3. Alarm Gong: Cast aluminum with red-enamel factory finish.
   4. Size: 10-inch (250-mm) diameter.
   5. Components: Shaft length, bearings, and sleeve to suit wall construction.
   6. Inlet: NPS 3/4 (DN 20).
   7. Outlet: NPS 1 (DN 25) drain connection.

B. Electrically Operated Alarm Bell:
   1. Standard: UL 464.
   2. Type: Vibrating, metal alarm bell.
   3. Size: 6-inch (150-mm) minimum- (200-mm) (250-mm) diameter.
   4. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Water-Flow Indicators:
   1. Standard: UL 346.
   2. Water-Flow Detector: Electrically supervised.
   3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   4. Type: Paddle operated.
   5. Pressure Rating: 250 psig (1725 kPa).
   6. Design Installation: Horizontal or vertical.

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

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

2.11 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

C. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum (0 to 2070 kPa).

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

PART 3 EXECUTION

3.1 PREPARATION

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

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 211100 "Facility Fire-Suppression Water-Service Piping."

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

3.3 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.4 PIPING INSTALLATION

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

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

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

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

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

N. Fill sprinkler system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.5 JOINT CONSTRUCTION

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

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

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

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

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

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

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

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

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

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

N. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

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

3.6 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

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

3.7 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.8 SPRINKLER INSTALLATION

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

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

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

3.9 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

B. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."

1. Install two protective pipe bollards around each fire-department connection.

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

3.10 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

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

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

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

D. Prepare test and inspection reports.

3.12 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.13 PIPING SCHEDULE

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

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

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 30, black-steel pipe with cut--]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
1. Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 30, black-steel pipe with cut--]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
1. Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 30, black-steel pipe with cut--]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.14 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Upright and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION COMMON WORK RESULTS FOR PLUMBING
220500

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   6. Escutcheons.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   9. Painting and finishing.
   10. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

D. The following are industry abbreviations for plastic materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.

E. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Piping materials.
   2. Mechanical sleeve seals.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed. All sleeve locations shall be coordinated with Division 03 contractor.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

D. Coordination Meetings: Attend coordination meetings with the construction manager and all other trades for the purpose of coordinating the locations of all fire protection, plumbing, HVAC and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field.

E. Conflicts Between Trades: Resolve all conflicts with other trades at no additional cost to the Owner or Architect.

F. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of fire protection, plumbing, HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.

1.7 INTENT OF DRAWINGS AND SPECIFICATIONS

A. These specifications and attendant drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with present practices of the trade shall not relieve the Contractor from providing such additional labor and materials.

B. The drawings depicting plumbing work are diagrammatic and show, in their approximate location, symbols representing plumbing equipment and devices. The exact location of such equipment and devices shall be established in the field in accordance with instructions from the Architect and/or established by manufacturer's installation drawings and details.

1. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring plumbing connections to verify rough-in and connection locations.
2. Unless specifically stated to the contrary, no measurement of any plumbing drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the plumbing drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

1.8 DRAWINGS

A. The plumbing drawings do not attempt to show the complete details of building construction which affect the plumbing installation. The Contractor shall refer to the architectural, civil, structural and mechanical, and electrical drawings for additional details which affect the proper installation of this work. Bring any discrepancies to the attention of the A/E for resolution. The Contractor is cautioned that diagrams showing plumbing connections and/or piping are diagrammatic only and must not be used for obtaining lineal runs of piping. Piping diagrams do not necessarily show the exact physical arrangement of the equipment.

B. The Contractor shall be responsible for all existing field conditions, review existing field conditions prior to bid and shall take into account in bid proposal. No additional compensation will be allowed due to Contractor's failure to include all necessary work in the bid proposal.

1.9 MATERIAL AND EQUIPMENT

A. All material and equipment shall be new and of the quality used for the purpose in good commercial practice, and shall be standard product of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, catalog number, and capacity or rating on a nameplate, securely affixed on the equipment in a conspicuous place.

1.10 DAMAGE TO OTHER WORK

A. The Plumbing Contractor will be held rigidly responsible for all damages to the work of his own or any other trade resulting from the execution of his work. It shall be the Contractor's responsibility to adequately protect his work at all times. All damages resulting from his operations shall be repaired or the damaged portions replaced by the party originally performing the work, (to the entire satisfaction of the Engineer), and all cost thereof shall be borne by the Contractor responsible for the damage.

1.11 COOPERATION WITH OTHER TRADES

A. This Contractor shall completely cooperate with all other trades in the matter of planning and executing of the work. Every reasonable effort shall be made to prevent conflict and interferences as to space requirements, dimensions, locations, openings, sleeving or other matters which tend to delay or obstruct the work of any trade.

1.12 NEGLIGENCE

A. Should the Contractor fail to provide materials, templates, etc., or other necessary information causing delay or expense to another party, he shall pay the actual amount of the damages to the party who sustained the loss.

1.13 FIELD CHANGES

A. Should any change in drawings or specifications be required to comply with local regulations and/or field conditions, the Contractor shall refer same to Architect for approval before any work which deviates from the original requirements of the drawings and specifications is started. In the event of disagreements as to the necessity of such changes, the decision of the Architect shall be final.

1.14 CUTTING AND PATCHING

A. As necessary and with approval to permit the installation of piping or any part of the work under this branch. Any cost caused by defective or ill-timed work shall be by the party responsible there for. Patching of holes, openings, etc. resulting from the work of this branch shall be furnished by this Contractor.

1.15 STANDARDS, CODES AND PERMITS

A. All work shall be installed in accordance with National, State and Local plumbing codes, laws, ordinances and regulations. Comply with all applicable OSHA regulations.

B. All materials shall have a U.L. label where a U.L. standard and/or test exists.

C. Prepare and submit to all authorities having jurisdiction, for their approval, all applications and working drawings required by them. Secure and pay for all permits and licenses required.

1.16 CLEAN-UP

A. This Contractor shall at all times keep the premises free from excessive accumulation of waste material or rubbish resulting from his work, including tools, scaffolding and surplus materials, and he shall leave his work broom-clean or its equivalent. In case of disputes, the Architect may order the removal of such rubbish and charge the cost to the responsible contractor as determined by the Architect. At the time of final clean-up all fixtures and equipment shall be thoroughly cleaned and left in proper condition for their intended use.

1.17 GUARANTEE

A. The Contractor shall unconditionally guarantee his work and all components thereof for a period of one year from the date of his final payment. He shall remedy any defects in workmanship and repair or replace any faulty equipment which shall appear within the guarantee period to the entire satisfaction of the Architect at no additional charge.

1.18 TEMPORARY PLUMBING

A. Temporary water includes all required up to the time of substantial completion.

1.19 SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN

A. Such requests shall be accompanied by three copies of all necessary illustrations, cuts, drawings and descriptions of material proposed for substitution and shall fully describe all points in which it differs from the articles specified. The Engineer will retain two copies and one copy returned to the Contractor with acceptance, rejection or revisions indicated thereon.

B. The proposed substitution does not affect dimensions shown on Drawings or as specified.

C. The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.

D. All proposed substitutions will be subject to satisfactory performance to the specification and considered as a deduct alternate rather than as an equivalent.

E. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs, including architectural/engineering design and construction costs, involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.

1.20 SHOP DRAWINGS

A. Submit to Engineer for review, copies of manufacturer's shop drawings and/or equipment brochure depicting items in this specification.

B. Other materials at the request of the Engineer.

C. Shop drawings shall bear the Contractor's stamp indicating approval.

D. Any equipment fabrication prior to shop drawing review shall be at the Contractor's risk.

1.21 WORKMANSHIP

A. The installation of all work shall be made so that its several component parts will function as a workable system complete with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The work shall be executed in conformity with the best-accepted standard practice of the trade so as to contribute to efficiency and appearance. It shall also be executed so that the installation will conform and adjust itself to the building structure, its equipment and its usage.

1.22 DRAWINGS OF OTHER TRADES

A. The Contractor shall consult the drawings of the work for the various other trades; field layouts of the parties performing the work of the other trades; their shop drawings, and he shall be governed accordingly in laying out his work.

1.23 FIELD MEASUREMENTS

A. The Contractor shall take all field measurements necessary for his work and shall assume the full responsibility for their accuracy.

1.24 STRUCTURAL INTERFERENCES

A. Should any structural interference prevent the installation of the fixtures, running of piping, etc., at points shown on drawings, the necessary minor deviation there from, as determined by the Architect, may be permitted. Minor changes in the position of the fixtures, equipment or piping if decided upon before any work has been done by the Contractor shall be made without additional charge.

1.25 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

A. Before submitting a bid, the Contractor shall visit the site and familiarize himself with all features of the building and site, which may affect the execution of his work. No extra payment will be allowed for the failure to obtain this information. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points with the Engineer before submitting his bid. In lieu of written clarification by addendum, the contractor shall resolve all conflicts in favor of the greater quantity or better quality.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

F. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:
   a) Cascade Waterworks Mfg. Co.
   b) Dresser Industries, Inc.; DMD Div.
   c) Ford Meter Box Company, Incorporated (The); Pipe Products Div.
   d) Viking Johnson.
2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.

4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

D. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

1. Manufacturers:
   a) Eclipse, Inc.
   b) Epco Sales, Inc.
   c) Hart Industries, International, Inc.
   d) Watts Industries, Inc.; Water Products Div.
   e) Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:
   a) Calpico, Inc.
   b) Lochinvar Corp.

E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:
   a) Precision Plumbing Products, Inc.
   b) Sioux Chief Manufacturing Co., Inc.
   c) Victaulic Co. of America.

2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. PVC Pipe: ASTM D 1785, Schedule 40.

2.7 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c) Insulated Piping: One-piece, stamped-steel type with spring clips.
      d) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
      f) Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.

g) Bare Piping in Equipment Rooms: One-piece, cast-brass type.
h) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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

L. Permanent sleeves are not required for holes formed by removable PE sleeves.

M. Install sleeves for pipes passing through concrete and masonry walls, and concrete footing, foundation, floor and roof slabs. Coordinate all sleeve locations with Division 03 contractor.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
a) Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
b) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
c) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

P. Verify final equipment locations for roughing-in.

Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

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

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

I. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

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

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.7 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 22 05 13
220513

PART 1 GENERAL

1.1 SUMMARY

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

1.2 COORDINATION

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

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

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficiency, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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

2.5 SINGLE-PHASE MOTORS

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

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

C. Motors 1/20 HP and Smaller: Shaded-pole type.

D. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 22 05 23
220523

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Bronze swing check valves.
3. Bronze gate valves.
4. Iron, single-flange butterfly valves.
5. Iron swing check valves.
6. Iron gate valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. OS&Y: Outside screw and yoke.

D. RS: Rising stem.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

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

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

D. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Solder Joint: With sockets according to ASME B16.18.
   3. Threaded: With threads according to ASME B1.20.1.

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

2.2 BRONZE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ball Valves: Apollo Valves, Hammond Valve, Milwaukee Valve Company, NIBCO.
   2. Gate Valves: Hammond Valve, Milwaukee Valve Company, NIBCO.
   3. Check Valves: Hammond Valve, Milwaukee Valve Company, NIBCO, Watts.

B. Bronze Ball Valves: MSS SP-110, three piece bronze body with threaded ends, chrome-plated bronze ball, PTFE or TFE seat, 600 psig minimum CWP rating and blowout-proof bronze stem.
   1. NPS 2 and smaller: Full port.
   2. NPS 2-1/2 – NPS 3: Conventional port.

C. Rising Stem Gate Valves: MSS SP-80, Type 2, Class 125. ASTM B 62 bronze body with integral seat and screw-in bonnet; 200 psig minimum CWP rating; threaded ends; bronze stem, solid bronze wedge; graphite packing; malleable iron handwheel

D. Bronze Swing Check Valves: MSS SP-80, Type 3, Class 125. ASTM B 62 bronze body with renewable bronze disc and seat, threaded ends; suitable for installation in a horizontal or vertical line with upward flow..

2.3 IRON VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Full Lug Butterfly Valves: Hammond Valve, Milwaukee Valve Company, NIBCO, Watts.
   2. Gate Valves: Hammond Valve, Milwaukee Valve Company, NIBCO, Watts.
   3. Swing Check Valves: Hammond Valve, Milwaukee Valve Company, NIBCO, Watts.

B. Full Lug Iron Butterfly Valves: MSS SP-67, cast- or ductile-iron full lug body, rated for bi-directional dead end service at rated pressure without use of downstream flange (1035-kPa), bubble-tight shutoff.

1. CWP Rating:	200-psig (1380-kPa)minimum.
2. Disc:	Aluminum bronze ASTM B148
3. Lining:	EPDM lining
4. Stem:	Stainless steel stem with upper and lower alignment bearings

C. Iron Swing Check Valves: MSS SP-71, Type I; Class 125 cast iron body with bolted bonnet, flanged ends, renewable bronze seat and disc; suitable for installation in a horizontal or vertical line with upward flow.
   1. CWP Rating: 200 psig (1380 kPa) minimum.
   2. Body Design: Clear or full waterway.
   3. Gasket: Asbestos free.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

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

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

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

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

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

3.2 VALVE INSTALLATION

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

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

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

E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level or in vertical piping with upward flow.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

   1. Shutoff Service: Ball or butterfly valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service: Ball, or butterfly valves.
   4. Pump-Discharge Check Valves:
      a) NPS 1-1/2 (DN 50) and Smaller: Bronze swing check valves.
      b) NPS 2 (DN 65) and Larger for Domestic Water: Iron center-guided, silent check valves. Install silent check valve a minimum of five pipe diameters downstream of pump discharge.

3.5 VALVE APPLICATIONS

A. Water Supply and Return Piping:

1. Shutoff and Throttling Service:
   a) NPS 2 (DN 50) and Smaller: Bronze three-piece ball valves.
   b) NPS 2-1/2 (DN 65) (DN 50) and NPS 3 (DN 65) (DN 50): Bronze three-piece ball valves.
   c) NPS 4 and (DN 65)Larger: Iron butterfly valves.
2. Check Valves in Horizontal Piping or Vertical Piping with Upward Flow:
   a) NPS 3 (DN 50) and Smaller: Bronze swing check valves.
   b) NPS 4 and Larger: Iron swing check valves.

B. Waste Piping:
1. Shutoff Service:
   a) NPS 2 (DN 50) and Smaller: Ball valves.

END OF SECTION

SECTION 22 05 29
220529

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes hangers and supports for plumbing system piping and equipment.

B. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

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

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 PRODUCTS

2.1 STRUCTURAL SUPPORTS

A. Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support mechanical equipment.

B. Provide support, anchors, and sleeves compatible with atmosphere where located. For applications located in corrosive atmospheres such as chemical rooms or rooms with high moisture (LSS Building), use Stainless Steel version of hangers and supports model and type listed in this Section. All other areas shall use Galvanized Steel.

2.2 MANUFACTURERS

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

1. B-Line Systems, Inc.
2. Carpenter & Patterson, Inc.
3. Grinnell Corp.
4. Michigan Hanger Co., Inc.

5. National Pipe Hanger Corp.
6. Unistrut Corp.

2.3 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
   1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
   2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
   1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
   2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

C. Thermal-Hanger Shield Inserts: 100-psi (690-kPa) minimum compressive-strength insulation, encased in sheet metal shield.
   1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
   2. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
   3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
   4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
   5. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   2. Properties: Nonstaining, noncorrosive, and nongaseous.
   3. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 EXECUTION

3.1 GENERAL

A. Provide support, anchors, and sleeves compatible with atmosphere where located. For applications located in corrosive atmospheres such as chemical rooms or rooms with high moisture, use Stainless Steel version of hanger model and type listed in this Section. All other areas shall use Galvanized Steel.

3.2 HANGER AND SUPPORT APPLICATIONS

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

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
   1. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2 (DN15 to DN50).

2. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).
3. Adjustable Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8 (DN15 to DN200).

D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500).

E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
a) Light (MSS Type 31): 750 lb (340 kg).
b) Medium (MSS Type 32): 1500 lb (675 kg).
c) Heavy (MSS Type 33): 3000 lb (1350 kg).
2. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.

G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi (690-kPa) minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

3.3 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
1. Field assemble and install according to manufacturer's written instructions.

C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

D. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

I. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c) Do not exceed pipe stress limits according to ASME B31.9.
   2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a) Option: Thermal-hanger shield inserts may be used
   3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
      a) Option: Thermal-hanger shield inserts may be used
   4. Shield Dimensions for Pipe: Not less than the following:
      a) NPS 1/4 to NPS 3-1/2 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
      b) NPS 4 (DN100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   5. Insert Material: Length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 EQUIPMENT SUPPORTS

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

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

3.5 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

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

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

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

3.7 PAINTING

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

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

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

END OF SECTION

SECTION 22 05 53
220553

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following plumbing identification materials and their installation:
   1. Pipe markers.

1.2 COORDINATION

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

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

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

PART 2 PRODUCTS

2.1 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
   1. Colors: Comply with ASME A13.1, unless otherwise indicated.
   2. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers extending 360 degrees around pipe at each location.
   3. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils (0.08 mm) thick with pressure-sensitive, permanent-type, self-adhesive back.
   1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

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

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:

1. Domestic Cold Water Piping:

    a) Background Color: Dark Green.
    b) Letter Color: White.

2. Domestic Hot Water Piping:

    a) Background Color: Light Green.
    b) Letter Color: White.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape: 1-1/2 inches (38 mm) (50 mm), round.

2. Letter Color: Black

3.5 WARNING-TAG INSTALLATION

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

3.6 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION

SECTION 22 07 19
220719

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:
   1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
   2. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe insulation shields and protection saddles.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.4 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

C. Coordinate installation and testing of electric heat tracing.

1.5 SCHEDULING

A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Mineral-Fiber Insulation:
      a) CertainTeed Manson.
      b) Knauf FiberGlass GmbH.
      c) Owens-Corning Fiberglas Corp.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
   1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
   2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
      a) Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
      b) Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
   3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
   4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
   5. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
   6. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

B. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in performing insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils (0.5 mm) thick; roll stock ready for shop or field cutting and forming.
   1. Adhesive: As recommended by insulation material manufacturer.
   2. PVC Jacket Color: White or gray.

C. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- (0.5-mm-) thick, high-impact, ultraviolet-resistant PVC.
   1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
   2. Adhesive: As recommended by insulation material manufacturer.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd. (270 g/sq. m).
   1. Tape Width: 4 inches (100 mm).

B. Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:
   1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.
   2. Galvanized Steel: 0.005 inch (0.13 mm) thick.
   3. Aluminum: 0.007 inch (0.18 mm) thick.
   4. Brass: 0.010 inch (0.25 mm) thick.
   5. Nickel-Copper Alloy: 0.005 inch (0.13 mm) thick.

C. Wire: 0.080-inch (2.0-mm), nickel-copper alloy; 0.062-inch (1.6-mm), soft-annealed, stainless steel; or 0.062-inch (1.6-mm), soft-annealed, galvanized steel.

2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

2.6 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a) McGuire Manufacturing.
    b) Truebro; a brand of IPS Corporation.
    c) Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
    1. Apply insulation continuously through hangers and around anchor attachments.
    2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
    3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:
   1. Pull jacket tight and smooth.
   2. Circumferential Joints: Cover with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100 mm) o.c.
   3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches (40 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
      a) Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
   4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
   5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

Q. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
   1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."

R. Floor Penetrations: Apply insulation continuously through floor assembly.
   1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:
   1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
   2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet (4.5 to 6 m) to form a vapor retarder between pipe insulation segments.
   3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:
   1. Apply preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:
   1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.

3. Cover fittings with standard PVC fitting covers.

D. Apply insulation to valves and specialties as follows:
   1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
   3. Apply insulation to flanges as specified for flange insulation application.
   4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
   5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FIELD-APPLIED JACKET APPLICATION

A. Apply PVC jacket on all exposed insulated piping and in all areas with washdown activities, with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal water tight with manufacturer's recommended adhesive.

3.6 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
   1. Flexible connectors.
   2. Vibration-control devices.
   3. Fire-suppression piping.
   4. Drainage piping located in crawl spaces, unless otherwise indicated.
   5. Below-grade piping, unless otherwise indicated.
   6. Chrome-plated pipes and fittings, unless potential for personnel injury.
   7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.7 FIELD QUALITY CONTROL

A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
   1. Inspect fittings and valves randomly selected by Architect.

B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.8 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.9 INTERIOR INSULATION APPLICATION SCHEDULE

A. Service: Domestic hot water.
   1. Operating Temperature: 60 to 140 deg F (15 to 60 deg C).
   2. Insulation Material: Mineral fiber with ASJ Jacket
   3. Insulation Thickness for piping up to and including 2”: 1 inch thick minimum.

4. Field-Applied Jacket: PVC on all exposed piping and all areas subject to washdown activities.
5. Vapor Retarder Required: No.

B. Service: Domestic cold water.
1. Operating Temperature: 35 to 60 deg F (2 to 15 deg C).
2. Insulation Material: Mineral fiber with ASJ Jacket
3. Insulation Thickness: 1 inch thick minimum.
4. Field-Applied Jacket: PVC on all exposed piping and all areas subject to washdown activities.
5. Vapor Retarder Required: Yes.

C. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.
1. Operating Temperature: 35 to 140 deg F (2 to 49 deg C).
2. Insulation Material: Molded vinyl.
3. Insulation Thickness: 1/8 inch thick

D. Service: Storm Piping – All horizontal piping up to roof drain body.
1. Operating Temperature: 35 to 60 deg F (2 to 15 deg C).
2. Insulation Material: Mineral fiber with ASJ Jacket
3. Insulation Thickness: 1 (one) inch minimum.
4. Field-Applied Jacket: PVC on all exposed piping and all areas subject to washdown activities.
5. Vapor Retarder Required: Yes.

END OF SECTION

SECTION 22 11 16
221116

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aboveground domestic water pipes, tubes, and fittings inside buildings.

1.2 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

1.3 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner no fewer than 14 days in advance of proposed interruption of water service.
   2. Do not interrupt water service without Owner's written permission.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

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

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

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

F. Appurtenances for Grooved-End Copper Tubing:
   1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
   2. Mechanical Couplings for Grooved-End Copper Tubing:

      a) Copper-tube dimensions and design similar to AWWA C606.
      b) Ferrous housing sections.
      c) EPDM-rubber gaskets suitable for hot and cold water.
      d) Bolts and nuts.
      e) Minimum Pressure Rating: 300 psig (2070 kPa).

2.3 DUCTILE-IRON PIPE AND FITTINGS

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

B. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110/A21.10, ductile or gray iron, with AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153/A21.53, ductile iron; with AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Standard-Pattern, Push-on-Joint Fittings: AWWA C110/A21.10, ductile or gray iron with AWWA C111/A21.11, rubber gaskets.

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

2.4 CPVC TUBE AND FITTINGS

A. CPVC Pipe: ASTM F 441/ASTM 441M, Schedule 80.

B. CPVC Socket Fittings: ASTM F 439, Schedule 80.

C. CPVC Threadded Fittings: ASTM F 437, Schedule 80.

2.5 PEX TUBE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.6 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
   1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
   2. Full-face or ring type unless otherwise indicated.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve inside the building at each domestic water-riser. Comply with requirements for drain valves in Division 22 Section "Domestic Water Piping Specialties."

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water pressure reducing valves downstream from shutoff valves. Comply with requirements for pressure reducing valves in section Division 22 Section “Domestic Water Piping Specialties.”

G. Install domestic water piping level without pitch and plumb.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping to permit valve servicing.

L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

P. Install pressure gages on suction and discharge piping for each plumbing pump. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping."

Q. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 Section "Domestic Water Pumps."

R. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22 Section "Meters and Gages for Plumbing Piping."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

G. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

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

J. Install transition couplings at joints of dissimilar piping.

K. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c) Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

F. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
2. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
3. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

    a) Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b) During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

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

    c) Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    d) Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

    a) Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    b) Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    c) Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    d) Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    e) Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
    f) Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a) Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b) Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.8 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

      a) Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b) Fill and isolate system according to either of the following:

         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

      c) Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d) Repeat procedures if biological examination shows contamination.
      e) Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.9 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Underground domestic water piping:
   1. NPS 2 and smaller: PEX piping.

E. Combined domestic water, building service, and fire service main piping:
   1. Mechanical joint, ductile iron, standard pattern, mechanical joint fittings, and mechanical joints.

F. Aboveground domestic water piping:
   1. NPS 3 (DN 80) and smaller: Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. NPS 4 (DN 100 to DN 200) shall be one of the following:
      a) CPVC, Schedule 80: socket fittings; and solvent-cemented joints.
      b) CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.

3.10 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.

2. Throttling Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

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PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Mixing valves.
6. Strainers.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water-hammer arresters.
11. Air vents.
12. Water meters.

B. Related Requirements:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.
3. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

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

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

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

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Conbraco Industries, Inc.
   b) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Conbraco Industries, Inc.
   b) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c) Woodford Manufacturing Company; a division of WCM Industries, Inc.
   d) Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts model 9D or comparable product by one of the following:
   a) Conbraco Industries, Inc.
   b) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: (DN 15)NPS 3/4 (DN 20).
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts model LF909 or comparable product by one of the following:
   a) Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
   b) Conbraco Industries, Inc.
   c) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
5. Size: (DN)Same size as piping.
6. Body: (DN 50)Cast iron with interior lining that is FDA approved.
7. End Connections: Flanged for NPS 2-1/2 (DN 65) and larger.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:
   a) Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
   b) Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   a) Armstrong International, Inc.

b) NIBCO Inc.
c) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Type: Ball valve with two readout ports and memory-setting indicator.
3. Body: Brass or bronze.
4. Size: Same as connected piping, but not larger than NPS 2 (DN 50).
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.6 WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

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

a) Lawler Manufacturing Company, Inc.
b) Leonard Valve Company.
c) Powers; a division of Watts Water Technologies, Inc.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Chrome-plated bronze.
8. Tempered-Water Setting: 105 deg F**.**

B. Primary, Thermostatic, Water Mixing Valves:

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

a) Lawler Manufacturing Company, Inc.
b) Leonard Valve Company.
c) Powers; a division of Watts Water Technologies, Inc.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Rough bronze.
9. Piping Finish: Copper

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
   a) Strainers NPS 2 (DN 50) and Smaller: 0.062 inch (1.57 mm).
   b) Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.125 inch (3.18 mm).

6. Drain: Pipe plug.

2.8 HOSE BIBBS

A. Hose Bibbs:

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

   a) Watts Drainage Products.
   b) Woodford Manufacturing Company; a division of WCM Industries, Inc.
   c) Zurn Industries, LLC; Plumbing Products Group; Light Commercial Productc.

2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig (860 kPa).
8. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Chrome or nickel plated.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Equipment Rooms: Wheel handle or operating key.
13. Operation for Service Areas: Operating key.
14. Operation for Finished Rooms: Operating key.
15. Include operating key with each operating-key hose bibb.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

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

   a) Watts Drainage Products.
   b) Woodford Manufacturing Company; a division of WCM Industries, Inc.
   c) Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.

2. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Chrome plated.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): Two with each wall hydrant.

2.10 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

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

   a) Precision Plumbing Products, Inc.
   b) Watts Drainage Products.
   c) Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 (DN 10)minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.13 WATER METERS

A. Displacement-Type Water Meters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:

   a) Badger Meter, Inc.
   b) Carlon Meter.
   c) Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.

2. Description:

   a) Standard: AWWA C700, NSF/ANSI 61 and 372.
   b) Pressure Rating: 150-psig (1035-kPa) working pressure.
   c) Body Design: Nutating disc; totalization meter.
   d) Case: Bronze.
   e) End Connections: Threaded.
   f) Encoder: High resolution fully electronic, solid-state encoder.

2.14 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of each control valve and pump.

F. Install water-hammer arresters in water piping according to PDI-WH 201.

G. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

2.15 CONNECTIONS

A. Comply with requirements for piping specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for ground equipment in Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Fire-retardant-treated-wood blocking is specified in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

2.16 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Carbonated-beverage-machine backflow preventers.
5. Reduced-pressure-detector assemblies.
6. Water pressure-reducing valves.
7. Calibrated balancing valves.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

2.17 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each reduced-pressure-principle zone assemblies according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

2.18 ADJUSTING

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

B. Set field-adjustable flow set points of balancing valves.

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

END OF SECTION

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PART 1 GENERAL

1.1 SUMMARY

A. Section includes simplex, variable-speed booster pump systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

B. ASME Compliance: Comply with ASME B31.9 for piping.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for materials that will be in contact with potable water.

D. UL Compliance for Packaged Pumping Systems:

1. UL 508, "Industrial Control Equipment."
2. UL 508A, "Industrial Control Panels."
3. UL 778, "Motor-Operated Water Pumps."
4. UL 1995, "Heating and Cooling Equipment."

E. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

F. Factory Testing: The booster system shall be hydrostatically tested and shall undergo a complete electric and hydraulic test from 0 to 100% design flow at the factory. All control devices including transmitters and all safety features shall be factory calibrated and tested. The owner’s representative may witness the test.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain protective coatings and flange's protective covers during storage.

PART 2 PRODUCTS

2.1 SIMPLEX, VARIABLE-SPEED BOOSTER PUMPS

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a) Bell & Gossett.
   b) Grundfos
   c) SyncroFlo

B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, motors, piping, valves, specialties, and controls, and mounted on base.

C. Pumps:
   1. Type: NSF certified end suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
   2. Casing: Radially split; stainless-steel.
   3. Impeller: Closed, stainless-steel statically and dynamically balanced and keyed to shaft.
   4. Shaft and Shaft Sleeve: Stainless-steel shaft, with stainless-steel shaft sleeve and deflector.
   5. Seal: Mechanical.
   6. Orientation: Mounted horizontally or vertically.

D. Motors: Variable speed, with grease-lubricated or pre-greased, permanently shielded, ball-type bearings. Select motors that will not overload through full range of pump performance curve.

E. Piping: Copper tube and fittings or stainless-steel pipe and fittings.

F. Valves:
   1. Shutoff Valves NPS 2 and Smaller: two-piece, full-port ball valve, in each pump's suction and discharge piping.
   2. Shutoff Valves NPS 2-1/2 and Larger: Lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
   3. Check Valves: Silent type in each pump's discharge piping.
   4. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

G. Dielectric Fittings: With insulating material isolating joined dissimilar metals.

H. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for multiple-pump, variable-speed operation, with load control and protection functions.
   1. Control Logic: Solid-state system with transducers, programmable microprocessor, VFC, and other devices in controller.
   2. Motor Controller: NEMA ICS 2, variable-frequency, solid-state type.
      a) Control Voltage: 24-V ac, with integral control-power transformer.
   3. Enclosure: NEMA 250, Type 1 .
   4. Motor Overload Protection: Overload relay in each phase.
   5. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.
      a) Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.
   6. Pump Operation and Sequencing: Pressure-sensing method.
      a) Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.
   7. VFC: Voltage-source, pulse-width, modulating-frequency converter for each pump.
   8. Manual Bypass: Magnetic contactor arranged to transfer to constant-speed operation upon VFC failure.
   9. Instrumentation: Suction and discharge pressure gages.
   10. Lights: Running light for each pump.
   11. Alarm Signal Device: Sounds alarm when backup pumps are operating.
      a) Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with automatic reset.
   12. Thermal-bleed cutoff.
   13. Low-suction-pressure cutout.
   14. High-suction-pressure cutout.
   15. Low-discharge-pressure cutout.
   16. High-discharge-pressure cutout.
   17. Building Automation System Interface: Provide auxiliary contacts for interface to BACnet building automation system. Building automation systems are specified in Division 23 Section "Instrumentation and Control for HVAC." Include the following:
      a) On-off status of each pump.
      b) Alarm status.
      c) System inlet pressure.

d) System outlet pressure.

I. Base: Structural steel.

J. Capacities and Characteristics:

1. Minimum Pressure Rating: 125 psig.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

A. Equipment Mounting: Install booster pumps on concrete base using elastomeric pads . Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Minimum Deflection: 1/4 inch (6 mm) .
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.

1. Install shutoff valves on piping connections to booster-pump suction and discharge headers. Install ball, butterfly, or gate valves same size as suction and discharge headers. Comply with requirements for general-duty valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Install union, flanged, or grooved-joint connections on suction and discharge headers at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Division 22 Section "Domestic Water Piping."
3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge headers. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping."
4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers. Comply with requirements for flexible connectors specified in Division 22 Section "Domestic Water Piping."
5. Install piping adjacent to booster pumps to allow service and maintenance.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform visual and mechanical inspection.
2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

3.8 DEMONSTRATION

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

END OF SECTION

SECTION 22 11 23.23
221123.23

PART 1 GENERAL

1.1 SUMMARY

A. Section includes in-line, sealless centrifugal pumps:

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION

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

PART 2 PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Bell & Gossett Domestic Pump; ITT Corporation.
   2. Grundfos Pumps Corp.
   3. TACO Incorporated.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Pump Construction:

   1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
   2. Casing: Bronze, with threaded or companion-flange connections.
   3. Impeller: Plastic.

4. Motor: Single speed, unless otherwise indicated.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F (18 to 93 deg C).
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120-V ac.
7. Settings: Start pump at 105 deg F (41 deg C) (46 deg C) and stop pump at 120 deg F (49 deg C), adjustable.

B. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120-V ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

C. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.

1. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

D. Install pressure switches in water supply piping.

E. Install thermostats in hot-water return piping.

F. Install timers. Verify location with Owner.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties."

D. Connect thermostats and timers to pumps that they control.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats and timers] for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

    a) Verify bearing lubrication.
    b) Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c) Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

SECTION 22 13 16
221316

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes soil and waste, sanitary drainage and vent piping inside the building and to locations indicated.

B. Related Sections include the following:

1. Division 22 Section "Sanitary Waste Piping Specialties" for soil, waste, and vent piping systems specialties.

1.2 DEFINITIONS

A. The following are industry abbreviations for plastic and rubber piping materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. EPDM: Ethylene-propylene-diene terpolymer.
3. NBR: Acrylonitrile-butadiene rubber.
4. PVC: Polyvinyl chloride plastic.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).
2. Sanitary Sewer, Force-Main Piping: 50 psig (345 kPa) .

1.4 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

C. Transition Couplings for Underground Pressure Piping: AWWA C219 metal, sleeve-type coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 PVC PIPING

A. PVC Pipe: Schedule 40 ASTM D 2665, solid-wall drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. PVC Special Fittings: ASTM F 409, drainage-pattern tube and tubular fittings with ends as required for application.

PART 3 EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. All piping installed in plenums shall be plenum rated. No PVC piping is permitted in plenums.

C. Aboveground, Soil, Waste, and Vent Piping: Use any of the following piping materials for each size range:

1. NPS 1-1/4 to NPS 8 (DN 32 and DN 200): PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground, Soil, Waste, and Vent Piping: Use any of the following piping materials for each size range:

1. NPS 2 to NPS 4 4 (DN 40 to DN 100): PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping installation.

B. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

C. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

D. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

E. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

1. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:
   1. Individual, Straight, Horizontal Piping Runs: According to the following:
      a) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   2. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   3.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

E. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3 and 4 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.

F. Install supports for vertical PVC piping every 48 inches (1200 mm).

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Sections for plumbing fixtures.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Sanitary Waste Piping Specialties."
   4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

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

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION

SECTION 22 13 19
221319

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.
3. Floor sinks.
4. Roof flashing assemblies.
5. Through-penetration firestop assemblies.
6. Miscellaneous sanitary drainage piping specialties.
7. Flashing materials.
8. Grease interceptors.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. HDPE: High-density polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Grease interceptors.
2. Floor drains.
3. Floor sinks.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.1 CLEANOUTS

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

1. Josam Company; Blucher-Josam Div.
2. Smith, Jay R. Mfg. Co.; d of Smith Industries, Inc.
3. Watts Drainage Products Inc.
4. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Exposed Metal Cleanouts:

1. Standard: ASME A112.36.2M for PVC for cleanout test tee.
2. Size: Same as connected drainage piping

3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
4. Closure: Countersunk, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Closure: Stainless-steel plug with seal.

C. Metal Floor Cleanouts FCO:

1. Standard: ASME A112.36.2M for adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Required.
6. Outlet Connection: Spigot.
7. Closure: Stainless steel plug with straight threads and gasket.
8. Adjustable Housing Material: Stainless steel with threads.
9. Frame and Cover Material and Finish: Stainless steel.
10. Frame and Cover Shape: Sqaure.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
13. Standard: ASME A112.3.1.

D. Metal Wall Cleanouts WCO:

1. Standard: ASME A112.36.2M for adjustable housing cleanout.
2. Size: Same as connected drainage piping.
3. Body or Ferrule: Cast iron.
4. Closure: Countersunk brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Floor Drains: Refer for Plumbing Fixture Schedule for construction and accessories.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Josam Company; Josam Div.
   b) Sioux Chief Manufacturing Company
   c) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d) Watts Drainage Products Inc.
   e) Zurn Plumbing Products Group
2. Standard: ASME A112.6.3.

2.3 FLOOR SINKS

A. Floor Sinks **FS-1**: Refer for Plumbing Fixture Schedule for size and accessories.

1. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Josam Company; Josam Div.
   b) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c) Watts Drainage Products Inc.
   d) Zurn Plumbing Products Group
2. Standard: ASME A112.6.3.
3. Body Material: Stainless Steel.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

B. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm-) (30-kg/sq. m) (2.4-mm-)thick, lead flashing collar and skirt extending at least 6 inches (150 mm) (200 mm) (250 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

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

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
   2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
   3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.

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

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

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

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

2.7 GREASE INTERCEPTORS

A. Grease Interceptors **GI-1**: Refer for Plumbing Fixture Schedule for size and accessories.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) MIFAB, Inc.
      b) Josam Company; Josam Div.
      c) Rockford Sanitary Systems, Inc.
      d) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   2. Standard: ASME A112.14.3, for intercepting and retaining fats, oils, and greases from food-preparation wastewater.
   3. Body Material: Polyethylene.
   4. End Connections: Flanged.
   5. Cleanout: Integral or field installed on outlet.
   6. Mounting: Floor.
   7. Flow Control: Required.
   8. Operation: Manual cleaning.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
   4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a) Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
      b) Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
      c) Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. Assemble open drain fittings and install with top of hub (25 mm) 2 inches (51 mm) above floor.

H. Install vent caps on each vent pipe passing through roof.

I. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
   1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
   2. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Division 22 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

D. Grease Removal Devices: Connect controls, electrical power, factory-furnished accessories, and inlet, outlet, and vent piping to unit.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Grease interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.4 FIELD QUALITY CONTROL

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

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION STORM DRAINAGE PIPING
221413

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes storm-drainage piping inside the building and to locations indicated.

1.2 DEFINITIONS

A. The following are industry abbreviations for plastic piping materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.
   2. Storm Drainage, Force-Main Piping: 100 psig.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Flexible Transition Couplings for Underground Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

C. Transition Couplings for Underground Pressure Piping: AWWA C219 metal, sleeve-type coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 PVC PIPING

A. PVC Pipe: ASTM D 1785, D 2665, D 3034, F891 solid-wall drain, waste, and vent.
   1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns.

2.3 PE ENCASEMENT

A. PE Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105 PE film, 0.008-inch minimum thickness, tube or sheet.

PART 3 EXECUTION

3.1 EXCAVATION

A. Refer to Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground pressure piping, unless otherwise indicated.

C. All piping located within plenum ceilings shall be cast-iron. PVC piping shall not be permitted in plenums.

D. Aboveground Storm Drainage Piping: Use the following piping materials for each size range:

1. NPS 2 to NPS 4: PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. NPS 5 and NPS 6: Use NPS 6 PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. NPS 8: PVC pipe, PVC socket fittings, and solvent-cemented joints
4. All piping located within plenum ceilings shall be cast-iron. PVC piping shall not be permitted in plenums. Cast-iron piping shall follow the same sizing criteria as PVC

E. Underground Storm Drainage Piping: Use the following piping materials for each size range:

1. NPS 2 to NPS 4: PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. NPS 5 and NPS 6: Use NPS 6 PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. NPS 8: PVC pipe, PVC socket fittings, and solvent-cemented joints.

F. Aboveground Storm Drainage Force Mains: Use any of the following piping materials for each size range:

1. NPS 2 to NPS 4: PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. NPS 5 and NPS 6: Use NPS 6 PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. NPS 8: PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. All piping located within plenum ceilings shall be cast-iron. PVC piping shall not be permitted in plenums. Cast-iron piping shall follow the same sizing criteria as PVC

G. Underground Storm Drainage Force Mains: Use any of the following piping materials for each size range:

1. NPS 2 to NPS 4: PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. NPS 5 and NPS 6: Use NPS 6 PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. NPS 8: PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Refer to Division 2 Section "Storm Drainage" for Project site storm sewer and drainage piping.

B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.

C. Install cleanouts at base of stack all stacks as required by code.

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight.

F. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

G. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

H. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

I. Install force mains at elevations indicated.

J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

K. Install PVC storm drainage piping according to ASTM D 2665.

L. Install underground PVC storm drainage piping according to ASTM D 2321.

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

A. Shutoff Valves: Install shutoff valve on each sump pump discharge.
1. Use gate or full-port ball valve for piping NPS 2 and smaller.
2. Use gate valve for piping NPS 2-1/2 and larger.

B. Check Valves: Install swing check valve, downstream from shutoff valve, on each sump pump discharge.

C. Backwater Valves: Install backwater valves in piping subject to backlog.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
2. Install backwater valves in accessible locations.

3.6 HANGER AND SUPPORT INSTALLATION

A. Refer to Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
a) 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b) Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c) Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

E. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.

5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

F. Install supports for vertical PVC piping every 48 inches.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Connect force-main piping to the following:
   1. Storm Sewer: To exterior force main or storm manhole.
   2. Sump Pumps: To sump pump discharge.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

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

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

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

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION STORM DRAINAGE PIPING SPECIALTIES
221423

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Flashing materials.

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 METAL ROOF DRAINS

A. Roof Drain **RD-1** (Primary Drainage):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) Josam Company; Blucher-Josam Div.
      b) Smith, Jay R. Mfg. Co.; d of Smith Industries, Inc.
      c) Watts Drainage Products Inc.
      d) Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.6.4, for general-purpose roof drains.
   3. Body Material: Galvanized cast iron.
   4. Dimension of Body: Refer to drawings
   5. Combination Flashing Ring and Gravel Stop: Required.
   6. Outlet: Bottom.
   7. Extension Collars: Required.
   8. Underdeck Clamp: Required.
   9. Expansion Joint: Required.
   10. Sump Receiver Plate: Required.
   11. Dome Material: Galvanized cast iron.

2.2 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M,12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).

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

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

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

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

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

PART 3 EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
   1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Install expansion joints, if indicated, in roof drain outlets.
   3. Position roof drains for easy access and maintenance.

B. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
   4. Locate cleanouts at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

F. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

G. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. (30-kg/sq. m) lead sheets, 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of 4.0-lb/sq. ft. (20-kg/sq. m) lead sheets, 0.0625-inch (1.6-mm) thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

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

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION FACILITY NATURAL-GAS PIPING
221923

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa), and is reduced to secondary pressure of 0.5 psig (3.45 kPa) or less.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For motorized gas valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

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

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

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

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
   1. Notify Owner and Architect no fewer than five days in advance of proposed interruption of natural-gas service.
   2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces.

PART 2 PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      a) Material Group: 1.1.
      b) End Connections: Threaded or butt welding to match pipe.
      c) Lapped Face: Not permitted underground.
      d) Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      e) Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
   5. Mechanical Couplings:
      a) Steel flanges and tube with epoxy finish.
      b) Buna-nitrile seals.
      c) Steel bolts, washers, and nuts.
      d) Coupling shall be capable of joining steel pipe to steel pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
   1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
   2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
   3. Corrugated stainless-steel tubing with polymer coating.
   4. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
   5. End Fittings: Zinc-coated steel.
   6. Threaded Ends: Comply with ASME B1.20.1.
   7. Maximum Length: 72 inches (1830 mm.)

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
   1. Copper-alloy convenience outlet and matching plug connector.
   2. Nitrile seals.

3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

D. T-Pattern Strainers:
1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

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

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig (862 kPa).
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
5. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig (862 kPa).
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated brass.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Separate packnut with adjustable-stem packing threaded ends.
6. Ends: Threaded, flared, or socket.
7. CWP Rating: 600 psig (4140 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
2. Plug: Bronze.

3. Ends: Threaded, socket, or flanged.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig (862 kPa).
6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A 126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig (862 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A 126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig (862 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) American Meter Company.
   b) Fisher Control Valves and Regulators; Division of Emerson Process Management.
   c) Maxitrol Company.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig (13.8 kPa) (34.5 kPa) (69 kPa).

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) Eaton Corporation; Controls Div.
      b) Harper Wyman Co.
      c) Maxitrol Company.
   2. Body and Diaphragm Case: Die-cast aluminum.
   3. Springs: Zinc-plated steel; interchangeable.
   4. Diaphragm Plate: Zinc-plated steel.
   5. Seat Disc: Nitrile rubber.
   6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
   8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
   9. Maximum Inlet Pressure: 1 psig (6.9 kPa) (13.8 kPa) (34.5 kPa).

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) Capitol Manufacturing Company.
      b) Matco-Norca, Inc.
      c) McDonald, A. Y. Mfg. Co.
      d) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      e) Wilkins; a Zurn company.
   2. Description:
      a) Standard: ASSE 1079.
      b) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C) (1035 kPa) (1725 kPa).
      c) End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
   a) Exception: Tubing passing through partitions or walls does not require striker barriers.
5. Prohibited Locations:
   a) Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   b) Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install sleeves for piping penetrations of walls, ceilings, and floors.

W. Install sleeve seals for piping penetrations of concrete walls and slabs.

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

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).

3.7 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

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

3.8 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural gas piping.

B. Install underground, natural gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 31 20 00 “Earth Moving” for excavating, trenching and backfilling.
   1. If natural gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal and protect joints.
   2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
   3. Replace pipe having damaged PE coating with new pipe.

D. Install fittings for changes in direction and branch connections.

3.11 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURE MORE THAN 0.25 PSIG AND LESS THAN 5 PSIG.

A. Aboveground branch piping NPS 2 1/2 and smaller shall be steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground branch piping NPS 3 and above shall be steel pipe with wrought-iron fittings and welded joints.

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

D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
   1. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be one of the following:
   1. Cast-iron, nonlubricated plug valve.

E. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Bronze plug valve.

END OF SECTION

SECTION 223400
223400

PART 1 GENERAL

1.1 SUMMARY

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

B. Water heater will be listed ETL listed to UL 795 or ANSI Z21.10.3/CSA 4.3 “Gas Water Heaters”

C. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

D. Water heater manufacturer certified to the ISO 9001 International Quality System.

E. ASME Compliance:
   1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

F. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.5 COORDINATION

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

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a) Structural failures including storage tank and supports.
      b) Faulty operation of controls.
      c) Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Periods: From date of Substantial Completion.
      a) Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
         1) Storage Tank, heating surfaces and combustion chamber: Fifteen years.
         2) Controls and Other Components: One year.

b) Compression Tanks: Five years.

PART 2 PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a) Bradford White Corporation.
      b) Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   2. Standard: ANSI Z21.10.3/CSA 4.3.
   3. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
   4. Storage-Tank Construction: ASME-code steel with 150-psig **(1035-kPa)** minimum working-pressure rating.
      a) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
         1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c) Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
   5. Factory-Installed Storage-Tank Appurtenances:
      a) Anode Rod: Replaceable magnesium.
      b) Dip Tube: Required unless cold-water inlet is near bottom of tank.
      c) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
      d) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
      e) Jacket: Steel with enameled finish.
      f) Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
      g) Temperature Control: Adjustable thermostat.
      h) Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
      i) Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) Amtrol Inc.
      b) Bell and Gossett
      c) Taco, Inc.
   2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   3. Construction:
      a) Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      b) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c) Air-Charging Valve: Factory installed.
   4. Capacity and Characteristics:
      a) Working-Pressure Rating: 150 psig (690 kPa)].
      b) Air Precharge Pressure: 12 psi

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.

F. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

G. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. 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.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor domestic-water heaters to substrate.

B. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 23 19 23 "Facility Natural-Gas Piping."

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

E. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

F. Fill domestic-water heaters with water.

G. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 23 19 23 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 22 34 36.23
223436.23

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial, gas-fired, high-efficiency fire tube, storage, domestic-water heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

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

1.3 CLOSEOUT SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

B. Water heater will be listed ETL listed to UL 795 or ANSI Z21.10.3/CSA 4.3 “Gas Water Heaters”

C. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

D. Water heater manufacturer certified to the ISO 9001 International Quality System.

E. ASME Compliance:

1. Provide ASME-code construction as indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

G. Water heaters with full rated input between 399,000 and 600,000 BTU will operate at a minimum 96% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol.

1.5 COORDINATION

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

1.6 WARRANTY

A. Storage tank, heating surfaces, and combustion chamber will have a manufacturer’s 15 year warranty (8 years non-prorated, 7 years prorated) covering manufacturing or material defects, waterside or fire side corrosion, leaks and/or the production of rusty water. Warranties must be direct provided from the water heater manufacturer. Warranties provide by distributors, contractors, sales representatives or third party insurers will be accepted.

B. Burner and all heater parts: 1 year.

PART 2 PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Gas-Fired, High-Efficiency Fire Tube, Storage, Domestic-Water Heaters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following or pre-approved equal:
   a) PVI Industries
2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Description: Manufacturer's proprietary design to provide at least 96 percent combustion efficiency at optimum operating conditions.
4. Construction: ASME-code steel with 150-psig (1035-kPa) minimum working-pressure rating.
   a) The water heater will be a vertical fire tube, design that is constructed and stamped in accordance with Section IV, Part HLW of the ASME code. Water heater will be National Board Registered for a working pressure of 150 psi and will be pressure tested at 1-1/2 times working pressure..
   b) Water heater will be a single-pass, down-fired, fire tube design contained within an integral storage tank.
   c) Tank, combustion chamber and fire tubes will be unlined. Lined or plated water heaters will not be acceptable.
   d) Tank, combustion chamber and fire tubes will be constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2and ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”
   e) Tank, will be welded utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.
   f) All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.
   g) Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.
   h) All water contacting tank surfaces will be non-porous and exhibit 0% water absorption.
   i) All tank connections/fittings will be non-ferrous or stainless steel.
   j) To preserve thermal efficiency, the water heater will not use or require a circulator piped from the hot water outlet to the cold water inlet of the heater for the purpose of temperature control during normal operation. Connection for a building return circulation line will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping. Connection to a sidearm tank, if used, will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping.
   k) Finished vessel will not require sacrificial or impressed current anodes and none will be used. Water heaters or sidearm storage tanks that employ anode rods of any type will not be acceptable.
   l) Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting UL, ANSI and FM standards for the input specified.
   m) Burner shall be stainless steel.
   n) Gas train components will capable of self-proportionating gas and air to maintain optimum combustion in response to varying vent pressures.
   o) At 500,000 BTU input and higher, the burner will employ non-linkage modulation utilizing only a VFD drive to vary gas and air.
   p) Burner NOx emissions will be less than 20 ppm when corrected to 3% oxygen.

q) Water heater will be a category IV, condensing appliance and vent through PVC or Polypropylene. Water heater will satisfy requirements for sealed combustion. Vents for inlet air and exhaust can terminate in different pressure zones.

2.2 DOMESTIC-WATER TRIM

A. As a minimum, the heater will be equipped with the following:
   1. Electronic flame monitoring.
   2. Electronic low flow water cutoff.
   3. An immersion operating control.
   4. An immersion UL listed temperature limiting device.
   5. An ASME rated temperature and pressure relief valve.

B. Operating and safety controls shall meet the requirements of UL 795 and FM.

C. The water heater will employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a BAS system.

D. A protocol gateway for BacNet IP shall be provided.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base.
   1. Maintain manufacturer's recommended clearances.
   2. Arrange units so controls and devices that require servicing are accessible.
   3. 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.
   4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Install anchor bolts to elevations required for proper attachment to supported equipment.
   7. Anchor domestic-water heaters to substrate.

B. Install gas-fired, domestic-water heaters according to NFPA 54.
   1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
   2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
   3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
   4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 22 19 23 "Facility Natural-Gas Piping."

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

E. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

F. Fill domestic-water heaters with water.

G. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 23 19 23 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters. A copy of the startup report shall be provided to the owner.

END OF SECTION

SECTION COMMERCIAL WATER CLOSETS
224213.13

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water closets.
   2. Flushometer valves.
   3. Toilet seats.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data

PART 2 PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

A. Water Closet **WC-1**: Wall mounted, top spud
   1. Manufacturer: Subject to compliance with requirements, Provide products by one of the following:
      a) American Standard America
      b) Kohler Co.
      c) Toto USA, Inc.
      d) Zurn Industries, LLC: Commercial Brass and Fixtures
   2. Bowl:
      a) Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
      b) Material: Vitreous china.
      c) Type: Siphon jet.
      d) Style: Flushometer valve.
      e) Height: Standard.
      f) Rim Contour: Elongated.
      g) Water Consumption: 1.28 gal. (4.8 L) per flush.
      h) Spud Size and Location: NPS 1-1/2 (DN 40); top.
   3. Flushometer Valve: WC-1.
   4. Toilet Seat: WC-1.
   5. Support:
      a) Standard: ASME A112.6.1M.
      b) Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

2.2 FLUSHOMETER VALVES

A. Diaphragm Flushometer Valves WC-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) Sloan Valve Company
      b) Toto USA, Inc.

c) Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig (860 kPa).
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. location and application.
10. Consumption: 1.28 gal. (4.8 L) (6 L) (13.2 L) per flush.
11. Minimum Inlet: NPS 1 (DN 25).
12. Minimum Outlet: NPS 1-1/4 (DN 32).

2.3 TOILET SEATS

A. Toilet Seats WC-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a) Church
b) Kohler Co.
c) Olsonite Seat Co.
d) TOTO USA, INC.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Stainless Steel
8. Seat Cover: Not required.
9. Color: White.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

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

3.2 INSTALLATION

A. Water-Closet Installation:
1. Install level and plumb according to roughing-in drawings.
2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:
1. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:
1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.

F. Joint Sealing:
1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION COMMERCIAL URINALS
224213.16

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Urinals.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data

PART 2 PRODUCTS

2.1 WALL-HUNG URINALS

A. Urinals UR-1: Wall hung.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) American Standard America
      b) Kohler Co.
      c) Toto USA, Inc.
      d) Zurn Industries, LLC: Commercial Brass and Fixtures
   2. Fixture:
      a) Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
      b) Material: Vitreous china.
      c) Type: Washout with extended shields.
      d) Strainer or Trapway: Manufacturer's standard strainer with integral trap.
      e) Water Consumption: 0.5 gal per flush
      f) Outlet Size and Location: NPS 2 (DN 50), back.
      g) Color: White.
   3. Waste Fitting:
      a) Standard: ASME A112.18.2/CSA B125.2 for coupling.
      b) Size: NPS 2 (DN 50).
   4. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

2.2 FLUSHOMETER VALVES

A. Diaphragm Flushometer Valves UR-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) Sloan Valve Company
      b) Toto USA, Inc.
      c) Zurn Industries, LLC; Commercial Brass and Fixtures.
   2. Standard: ASSE 1037.
   3. Minimum Pressure Rating: 125 psig (860 kPa).
   4. Features: Include integral check stop and backflow-prevention device.
   5. Material: Brass body with corrosion-resistant components.
   6. Exposed Flushometer-Valve Finish: Chrome plated.
   7. Panel Finish: Chrome plated or stainless steel.

8. Style: Exposed.
9. Consumption: 0.5 gal. (4.8 L) (6 L) (13.2 L) per flush.
10. Minimum Inlet: NPS ¾.
11. Minimum Outlet: NPS 1-1/4 (DN 32).

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.

B. Examine walls and floors for suitable conditions where urinals will be installed.

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

3.2 INSTALLATION

A. Urinal Installation:
   1. Install urinals level and plumb according to roughing-in drawings.
   2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
   3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.

B. Flushometer-Valve Installation:
   1. Install flushometer-valve, water-supply fitting on each supply to each urinal.
   2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

C. Support Installation:
   1. Install supports, affixed to building substrate, for wall-hung urinals.
   2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

D. Wall Flange and Escutcheon Installation:
   1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
   2. Install deep-pattern escutcheons if required to conceal protruding fittings.

E. Joint Sealing:
   1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
   2. Match sealant color to urinal color.

3.3 CONNECTIONS

A. Connect urinals with soil, waste, and vent piping. Use size fittings required to match urinals.

B. Comply with soil and waste piping requirements specified in Division 22 "Sanitary Waste and Vent Piping."

C. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

3.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.13
224216.13

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lavatories.
   2. Faucets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data,".

PART 2 PRODUCTS

2.1 LAVATORIES

A. Lavatory: **L-1:** Bowls are integral with solid surface counter (Supplied by Division 06 contractor). Only faucets are required. Refer to Manually Operated Lavatory Faucets and Plumbing Fixture Schedule for additional requirements.

B. Lavatory **L-2**: Vitreous china, wall mounted..
   1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:
      a) American Standard America
      b) Kohler Co.
      c) Zurn Industries, LLC: Commercial Brass and Fixtures
   2. Fixture:
      a) Standard: ASME A112.19.2/CSA B45.1.
      b) Type: For wall hanging.
      c) Faucet-Hole Punching: 4” on center.
      d) Faucet-Hole Location: Top.
      e) Color: White.
      f) Mounting Material: Chair carrier.
   3. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier.

2.2 MANUALLY OPERATED LAVATORY FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets L-1 & L-2: Manually operated, refer to Plumbing Fixture Schedule for additional requirements.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Chicago Faucets
   b) Kohler
   c) Toto
2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. General: ADA compliant handle; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Maximum Flow Rate: 0.5 gpm (1.5 L/min.).
5. Spout: Rigid type.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 (DN 32) offset and straight tailpiece.

C. Trap:
   1. Size: NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32) (DN 32).
   2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall; and chrome-plated, brass or steel wall flange.
   3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

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

3.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

C. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224216.16
COMMERCIAL SINKS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sinks.
   2. Service basins.
   3. Supply fittings.
   4. Waste fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 PRODUCTS

2.1 SINKS

A. Sink **S-1**: Sink is integral with stainless-steel counter (Supplied by Division 06 contractor). Only faucets are required. Refer to Plumbing Fixture Schedule for additional requirements.
   1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
      a) Chicago Faucets
      b) Elkay
      c) Kohler
   2. Fixture: Faucet
      a) Standards: ASME A112.19.3/CSA B125.1 and NSF/ANSI 61.
      b) Type: Pull down spray faucet.

B. Sink **S-2**: Refer to Plumbing Fixture Schedule for additional requirements.
   1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
      a) Aero
      b) Elkay
      c) John Boos
   2. Fixture: Sink and Faucet
      a) Standards: ASME A112.19.3/CSA B125.1 and NSF/ANSI 61.
      b) Type: 4 compartment sink with drain boards and pre-rinse faucet with 10” spout.
   3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.

4. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
5. Support: Include support bracket as required.
6. Provide P-trap and tailpiece per fixture schedule.
7. Drain: Grid with NPS 2 outlet and lever handle. Verify exact size with sink drain opening prior to purchase.

C. Sink **S-3**: Refer to Plumbing Fixture Schedule for additional requirements.
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   a) Aero
   b) Elkay
   c) John Boos
2. Fixture: Sink and Faucet
   a) Standards: ASME A112.19.3/CSA B125.1 and NSF/ANSI 61.
   b) Type: Hand sink with integral faucet.
3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
4. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
5. Support: Include support bracket as required.
6. Provide P-trap and tailpiece per fixture schedule.
7. Drain: Grid with NPS 1.5” outlet.

D. Sink **S-4**: Refer to Plumbing Fixture Schedule for additional requirements.
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   a) Elkay
   b) Kohler
   c) Mustee
2. Fixture: Sink and Faucet
   a) Standards: ASME A112.19.3/CSA B125.1, NSF/ANSI 61 and IAPMO/ANSI Z124.
   b) Type: Laundry room sink and gooseneck faucet.
3. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
4. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
5. Support: Include support bracket as required.
6. Provide P-trap and tailpiece per fixture schedule.
7. Drain: Grid with NPS 1.5” outlet.

2.2 MOP SINKS

A. Service Basins **MB-1**: One piece molded high impact resistant, floor mounted.
1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:
   a) Acorn Engineering Company.
   b) Fiat Products Co., Inc.
   c) Mustee Co., Inc.
2. Fixture:
   a) Standard: IAPMO/ANSI Z124.6
   b) Material: Cast Polymer
   c) Nominal Size: 24 by 24 be 10 inches.
   d) Color: White
   e) Drain: Stainless steel grid with NPS 3 (DN 80) outlet.
3. Mounting: On floor and flush to wall.
4. See drawing schedules for additional details.

B. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

C. Faucet: Manual type, two-lever-handle mixing valve.
1. Basis-of-Design Product: Subject to compliance with requirements, provide **p**roduct indicated on Drawings or comparable product by one of the following:
   a) Chicago Faucets.
   b) Kohler Co.

c) Moen Incorporated.
d) Stern Williams
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Material: Commercial, solid brass.
5. Finish: Chrome plated .
6. Maximum Flow Rate: 2.2 gpm (8.3 L/min.) .
7. Handle(s): Lever.
8. Mounting Type: Back/wall, exposed.
9. Spout Type: Rigid, solid brass with wall brace.
10. Vacuum Breaker: Required for hose outlet.
11. Spout Outlet: Hose thread according to ASME B1.20.7.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:
1. NPS 1/2**.**
2. Chrome-plated, rigid-copper pipe.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4, 1-1/2 (DN 40) or 2 offset and straight tailpiece.

C. Trap:
1. Size: NPS 1-1/4, 1-1/2 (DN 40) or 2.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall (0.83-mm-) (73-mm-); and chrome-plated brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick stainless-steel tube to wall; and stainless-steel wall flange.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Set floor-mounted sinks in leveling bed of cement grout.

D. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

F. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

G. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 23
COMMERCIAL SHOWERS, RECEPTORS, AND BASINS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shower faucets.
   2. Individual FRP Showers
   3. Shower head – Animal Yard
   4. Grout.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

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

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 PRODUCTS

2.1 SHOWER FAUCETS

A. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.

B. Shower Faucets SH-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) Kohler Co.
      b) Moen Incorporated.
      c) Powers; a division of Watts Water Technologies, Inc.
   2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
   3. Faucet:
      a) Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
      b) Body Material: Solid brass.
      c) Finish: Polished chrome plate.
      d) Maximum Flow Rate: 2.5 gpm **(9.5 L/min.)** unless otherwise indicated.
      e) Mounting: Concealed.
      f) Operation: Single-handle, push-pull or twist or rotate control.
      g) Antiscald Device: Integral with mixing valve.
      h) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
   4. Supply Connections: NPS 1/2 (DN 15).
   5. Shower Head: Handshower with slidebar, 60 inch metal shower hose, wall supply elbow and vacuum breaker.

a) Standard: ASME A112.18.1/CSA B125.1.
b) Shower Head Material: Metallic with chrome-plated finish.
c) Spray Pattern: Adjustable.

2.2 INDIVIDUAL FRP SHOWERS

A. Individual RFP Showers SH-1: Refer to Plumbing Fixture Schedule for accessories.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a) Aquarius
b) Aker, MAAX
c) Kohler Co.
2. Description: FRP shower enclosure with faucet and receptor.
a) Standards: ANSI Z124.1.2.
b) Type: One-piece unit without top.
c) Style: ADA
d) Nominal Size and Shape: 36 by 36 inches square.
e) Color: White
f) Bathing Surface: Slip resistant according to ASTM F 462.
g) Outlet: Drain with NPS 2 outlet.

2.3 SHOWER HEAD – ANIMAL YARD

A. Shower Head SH-2:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a) Bradley Corporation
b) Haws Corporation
c) Speakman Company
2. Description: Deluge shower head with impeller faceplate.
a) Standard: ANSI Z358.1.
b) Shower Head Material: Brass, nickel-plated
3. Supply Connections: NPS 1.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.

B. Examine walls and floors for suitable conditions where showers will be installed.

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

3.2 INSTALLATION

A. Assemble shower components according to manufacturers' written instructions.

B. Install showers level and plumb according to rough-in drawings.

C. Set shower stall in leveling bed of cement grout or per manufacturer’s installation requirements.

D. Install water-supply piping with stop on each supply to each shower faucet.
   1. Exception: Use ball valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
   2. Install stops in locations where they can be easily reached for operation.

E. Install shower flow-control fittings with specified maximum flow rates in shower arms.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 22 05 00 "Common Work Results for Plumbing."

G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 “Joint Sealants.”

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. Provide protective covering for installed fixtures and fittings.

END OF SECTION

SECTION 224500
224500

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following emergency plumbing fixtures:
   1. Combination units. – Outdoor systems
   2. Water-tempering equipment.

1.2 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. PVC: Polyvinyl chloride plastic.

D. Tepid: Approximately 80 deg F temperature.
   1. Allowable Variation: Plus or minus 5 deg F.

1.3 SUBMITTALS

A. Product Data: Include flow rates and capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each product indicated.

B. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilitiesabout plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.

E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.5 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. For fixture descriptions in other Part 2 articles where the subparagraph titles "Products" introduce a list of manufacturers and their products, the following requirements apply for product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified in other Part 2 articles.

2.2 COMBINATION UNITS

A. Combination Units: Plumbed, accessible, freestanding type with emergency shower and eyewash equipment. Provide models as indicated on plumbing fixture schedule located on plans.
   1. Manufacturers:
      a) Haws Corporation
      b) Bradley Corporation
      c) Guardian Equipment
      d) Speakman Company
   2. Types required as scheduled in Plumbing Fixture Schedule
      a) ES-1: Freeze Proof unit/system for installation of the shower and eyewash outdoors.
   3. Piping: Schedule Stainless Steel piping in corrosive areas, Schedule 40 galvanized steel pipe in none-corrosive areas.
      a) Unit Supply: NPS 1-1/4 (DN 32) minimum.
      b) Unit Drain: Outlet at side near bottom.
      c) Shower Supply: NPS 1 (DN 25) with flow regulator and stay-open control valve.
      d) Eyewash Supply: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
   4. Shower Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
      a) Control-Valve Actuator: Pull chain
      b) Shower Head: 8-inch (200-mm) minimum diameter, plastic.
   5. Eyewash Equipment: With capacity to deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
      a) Control-Valve Actuator: Paddle.
      b) Receptor: Plastic bowl.

2.3 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water-Tempering Equipment: Factory-fabricated equipment including water thermostatic mixing valve designed to provide 70 deg F potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, corrosion-resistant metal piping, and enclosure.
   1. Manufacturers:
      a) Haws Corporation
      b) Lawler Manufacturing Co., Inc.
      c) Leonard Valve Co.

2.4 SOURCE QUALITY CONTROL

A. Certify performance of plumbed emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components according to manufacturers written instructions.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Refer to Division 15 Section "Plumbing Valves" for general-duty shutoff valves.

1. Exception: Omit shutoff valves on valved supplies to group of plumbing fixtures that includes emergency plumbing fixture.
2. Exception: Omit shutoff valves on supplies to emergency equipment if prohibited by authorities having jurisdiction.

E. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping.

F. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Refer to Division 15 Section "Basic Plumbing Materials and Methods" for dielectric fittings.

G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.

H. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Refer to Division 15 Section "Sanitary Waste and Vent Piping" for piping.

I. Install alarm flow switch.

J. Mount Alarm and alarm light utilizing wall bracket. Coordinate Final location with Owner.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.

D. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.

E. Connect electrical Power and make interconnections as required for alarm flow switch, alarm buzzer and light. Coordinate signal output connections for tie-in to SCADA system for remote alarm monitoring.

F. Ground equipment.

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

3.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

B. Electrical-Component Testing: After electrical circuitry has been energized, test for compliance with requirements.

1. Test and adjust controls and safeties.

C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

D. Report test results in writing.

3.5 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION

SECTION COMMON WORK RESULTS FOR HVAC
230500

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   6. Escutcheons.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   9. Painting and finishing.
   10. Concrete bases.
   11. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

D. The following are industry abbreviations for plastic materials:
   1. PE: Polyethylene plastic.
   2. PVC: Polyvinyl chloride plastic.

E. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

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

1.5 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Panels."

D. Coordination Meetings: Attend coordination meetings with the construction manager and all other trades for coordinating the locations of all fire protection, plumbing, HVAC and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field.

E. Conflicts Between Trades: Resolve all conflicts with other trades at no additional cost to the Owner or Architect.

F. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of fire protection, plumbing, HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid or other ceiling finish structure unless there is no ceiling, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.

G. Areas open to structure (no finished ceilings): Coordinate to accommodate installation of fire protection, plumbing, HVAC and electrical work such that the installation is routed up and between the structural members and/or routed through structural member web openings to maximize ceiling heights available. Coordinate all locations where the installation must cross over or under a structural member with the project Architect/Engineer to avoid clearance conflicts.

1.6 INTENT OF DRAWINGS AND SPECIFICATIONS

A. These specifications and attendant drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with present practices of the trade shall not relieve the Contractor from providing such additional labor and materials.

B. The drawings depicting HVAC work are diagrammatic and show, in their approximate location, symbols representing HVAC equipment and devices. The exact location of such equipment and devices shall be established in the field in accordance with instructions from the Architect and/or established by manufacturer's installation drawings and details.

1. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring HVAC connections to verify rough-in and connection locations.
2. Unless specifically stated to the contrary, no measurement of any HVAC drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the HVAC drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

1.7 DRAWINGS

A. The HVAC drawings do not attempt to show the complete details of building construction which affect the HVAC installation. The Contractor shall refer to the architectural, civil, structural and plumbing, and electrical drawings for additional details which affect the proper installation of this work. Bring any discrepancies to the attention of the A/E for resolution. The Contractor is cautioned that diagrams showing HVAC connections and/or piping are diagrammatic only and must not be used for obtaining lineal runs of piping. Piping diagrams do not necessarily show the exact physical arrangement of the equipment.

B. The Contractor shall be responsible for all existing field conditions, review existing field conditions prior to bid and shall take into account in bid proposal. No additional compensation will be allowed due to Contractor's failure to include all necessary work in the bid proposal.

1.8 MATERIAL AND EQUIPMENT

A. All material and equipment shall be new and of the quality used for the purpose in good commercial practice, and shall be standard product of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, catalog number, and capacity or rating on a nameplate, securely affixed on the equipment in a conspicuous place.

1.9 DAMAGE TO OTHER WORK

A. The HVAC Contractor will be held rigidly responsible for all damages to the work of his own or any other trade resulting from the execution of his work. It shall be the Contractor's responsibility to adequately protect his work at all times. All damages resulting from his operations shall be repaired or the damaged portions replaced by the party originally performing the work, (to the entire satisfaction of the Engineer), and all cost thereof shall be borne by the Contractor responsible for the damage.

1.10 COOPERATION WITH OTHER TRADES

A. This Contractor shall completely cooperate with all other trades in the matter of planning and executing of the work. Every reasonable effort shall be made to prevent conflict and interferences as to space requirements, dimensions, locations, openings, sleeving or other matters which tend to delay or obstruct the work of any trade.

1.11 NEGLIGENCE

A. Should the Contractor fail to provide materials, templates, etc., or other necessary information causing delay or expense to another party, he shall pay the actual amount of the damages to the party who sustained the loss.

1.12 FIELD CHANGES

A. Should any change in drawings or specifications be required to comply with local regulations and/or field conditions, the Contractor shall refer same to Architect for approval before any work which deviates from the original requirements of the drawings and specifications is started. In the event of disagreements as to the necessity of such changes, the decision of the Architect shall be final.

1.13 CUTTING AND PATCHING

A. As necessary and with approval to permit the installation of piping or any part of the work under this branch. Any cost caused by defective or ill-timed work shall be by the party responsible there for. Patching of holes, openings, etc. resulting from the work of this branch shall be furnished by this Contractor.

1.14 STANDARDS, CODES AND PERMITS

A. All work shall be installed in accordance with National, State and Local Mechanical codes, laws, ordinances and regulations. Comply with all applicable OSHA regulations.

B. All materials shall have a U.L. label where a U.L. standard and/or test exists.

C. Prepare and submit to all authorities having jurisdiction, for their approval, all applications and working drawings required by them. Secure and pay for all permits and licenses required.

1.15 CLEAN-UP

A. This Contractor shall at all times keep the premises free from excessive accumulation of waste material or rubbish resulting from his work, including tools, scaffolding and surplus materials, and he shall leave his work broom-clean or its equivalent. In case of disputes, the Architect may order the removal of such rubbish and charge the cost to the responsible contractor as determined by the Architect. At the time of final clean-up all fixtures and equipment shall be thoroughly cleaned and left in proper condition for their intended use.

1.16 GUARANTEE

A. The Contractor shall unconditionally guarantee his work and all components thereof for a period of one year from the date of his final payment. He shall remedy any defects in workmanship and repair or replace any faulty equipment which shall appear within the guarantee period to the entire satisfaction of the Architect at no additional charge.

1.17 TEMPORARY HVAC

A. Temporary heat includes all required up to the time of substantial completion.

1.18 SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN

A. Such requests shall be accompanied by three copies of all necessary illustrations, cuts, drawings and descriptions of material proposed for substitution and shall fully describe all points in which it differs from the articles specified. The Engineer will retain two copies and one copy returned to the Contractor with acceptance, rejection or revisions indicated thereon.

B. The proposed substitution does not affect dimensions shown on Drawings or as specified.

C. The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.

D. All proposed substitutions will be subject to satisfactory performance to the specification and considered as a deduct alternate rather than as an equivalent.

E. Where equipment or accessories are used, which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs, including architectural/engineering design and construction costs, involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.

F. All substitution review costs shall be reimbursed to the Engineer by the contractor or their suppliers on a Time/Material bases. This cost shall be paid on approval or disproval of the substitution material, equipment or design.

1.19 SHOP DRAWINGS

A. Submit to Engineer for review, copies of manufacturer's shop drawings and/or equipment brochure depicting items in this specification.

B. Other materials at the request of the Engineer.

C. Shop drawings shall bear the Contractor's stamp indicating approval.

D. Any equipment fabrication prior to shop drawing review shall be at the Contractor's risk.

E. Any shop drawing not meeting the requirements as outlined in this or any other part of this specification or drawing, requiring more than two reviews or in excess of 4 hours of total review time shall have a fee of reimbursement to the Engineer by the contractor or their suppliers. This shall be done on a Time/Material bases. This cost shall be paid on approval or disproval of the material, equipment or design.

1.20 WORKMANSHIP

A. The installation of all work shall be made so that its several component parts will function as a workable system complete with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The work shall be executed in conformity with the best-accepted standard practice of the trade so as to contribute to efficiency and appearance. It shall also be executed so that the installation will conform and adjust itself to the building structure, its equipment and its usage.

1.21 DRAWINGS OF OTHER TRADES

A. The Contractor shall consult the drawings of the work for the various other trades; field layouts of the parties performing the work of the other trades; their shop drawings, and he shall be governed accordingly in laying out his work.

1.22 FIELD MEASUREMENTS

A. The Contractor shall take all field measurements necessary for his work and shall assume the full responsibility for their accuracy.

1.23 STRUCTURAL INTERFERENCES

A. Should any structural interference prevent the installation of the fixtures, running of piping, etc., at points shown on drawings, the necessary minor deviation there from, as determined by the Architect, may be permitted. Minor changes in the position of the fixtures, equipment or piping if decided upon before any work has been done by the Contractor shall be made without additional charge.

1.24 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

A. Before submitting a bid, the Contractor shall visit the site and familiarize himself with all features of the building and site, which may affect the execution of his work. No extra payment will be allowed for the failure to obtain this information. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points with the Engineer before submitting his bid. In lieu of written clarification by addendum, the contractor shall resolve all conflicts in favor of the greater quantity or better quality.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      a) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      a) Cascade Waterworks Mfg. Co.
      b) Dresser Industries, Inc.; DMD Div.
      c) Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      d) Viking Johnson.
   2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
   3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

D. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
   1. Manufacturers:
      a) Eclipse, Inc.
      b) Epco Sales, Inc.
      c) Hart Industries, International, Inc.
      d) Watts Industries, Inc.; Water Products Div.
      e) Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   1. Manufacturers:
      a) Calpico, Inc.
      b) Lochinvar Corp.

E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   1. Manufacturers:

a) Precision Plumbing Products, Inc.
b) Sioux Chief Manufacturing Co., Inc.
c) Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a) Advance Products & Systems, Inc.
      b) Calpico, Inc.
      c) Metraflex Co.
      d) Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. PVC Pipe: ASTM D 1785, Schedule 40.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c) Insulated Piping: One-piece, stamped-steel type with spring clips.
      d) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      f) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
      g) Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
      h) Bare Piping in Equipment Rooms: One-piece, cast-brass type
      i) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a) Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).

b) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
c) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

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

G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Nonpressure Piping: Join according to ASTM D 2855.

H. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

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

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230513

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes basic requirements for factory and field installed motors.

1.2 COORDINATION

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

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

B. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain field-installed motors through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 MOTOR REQUIREMENTS

A. Motor requirements apply to factory or field installed motors except as follows:
   1. Different ratings, performance, or characteristics for motor are specified in another Section.
   2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase.

B. Motors Smaller Than 1/2 HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open drip proof.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide with grounding rings.

2.5 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

E. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for conduit systems to verify actual locations of conduit connections before motor installation.

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

END OF SECTION

SECTION METERS AND GAGES FOR HVAC PIPING
230519

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.

PART 2 PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a) Miljoco Corporation.
      b) Trerice, H. O. Co.
      c) Weiss Instruments, Inc.
   2. Standard: ASME B40.200.
   3. Case: Cast aluminum; 7-inch (178-mm) nominal size unless otherwise indicated.
   4. Case Form: Adjustable angle unless otherwise indicated.
   5. Tube: Glass with magnifying lens and blue organic liquid.
   6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
   7. Window: Glass.
   8. Stem: Aluminum and of length to suit installation.
      a) Design for Thermowell Installation: Bare stem.
   9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:
   1. Standard: ASME B40.200.
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR.
   4. Material for Use with Steel Piping: CRES.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermowells for insulated piping and tubing.
   11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   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) Miljoco Corporation.
      b) Trerice, H. O. Co.
      c) Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      d) Weiss Instruments, Inc.
   2. Standard: ASME B40.100.
   3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
   8. Pointer: Dark-colored metal.
   9. Window: Glass.
   10. Ring: Metal.
   11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball with NPS 1/4 (DN 8) ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Miljoco Corporation.
   2. Trerice, H. O. Co.
   3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   4. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 (DN 8), ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

F. Core Inserts: Chlorosulfonated polyethylene synthetic self-sealing rubber.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

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

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

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

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install test plugs in piping tees.

H. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic boiler.

I. Install pressure gages in the following locations:
   1. Pump differential line.

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

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

END OF SECTION

SECTION GENERAL DUTY VALVES FOR HVAC PIPING
230523

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:
   1. Copper-alloy ball valves.
   2. Bronze check valves.

B. Related Sections include the following:
   1. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and charts.
   2. Division 23 Section "Instrumentation and Control Devices for HVAC" for control valves and actuators.
   3. Division 23 piping Sections for specialty valves applicable to those Sections only.

1.2 DEFINITIONS

A. The following are standard abbreviations for valves:
   1. CWP: Cold working pressure.
   2. EPDM: Ethylene-propylene-diene terpolymer rubber.
   3. NBR: Acrylonitrile-butadiene rubber.
   4. PTFE: Polytetrafluoroethylene plastic.
   5. TFE: Tetrafluoroethylene plastic.

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B31.9 for building services piping valves.
   2. ASME B16.10 and ASME B16.34 for ferrous valve dimension and design criteria.

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

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

C. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

D. Extended Valve Stems: On insulated valves.

E. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

F. Threaded: With threads according to ASME B1.20.1.

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

2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:
   1. Milwaukee Valve Company.
   2. NIBCO INC.
   3. Watts Regulator Company.

B. Copper-Alloy Ball Valves, General: MSS SP-110, 600-psig (4140-kPa) minimum CWP rating bronze body with chrome-plated brass ball; reinforced PTFE or TFE seats; lever handle and blowout-proof stem.

C. Three-Piece, Copper-Alloy Ball Valves: Full-port.

2.4 BRONZE SWING CHECK VALVES

A. Manufacturers:
   1. Milwaukee Valve Company.
   2. NIBCO INC.
   3. Watts Regulator Company.

B. Bronze Swing Check Valves: MSS SP-80 Type 3, Class 150, Y-pattern bronze body with renewable bronze disc and seat..

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

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

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

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

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

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

3.2 VALVE APPLICATIONS

A. Heating Water Piping:
   1. Shutoff Service:
      a) NPS 2 (DN 50) and Smaller: Ball valves.
   2. Throttling Service:
      a) NPS 2 (DN 50) and Smaller: Ball.
   3. Pump Discharge:
      a) NPS 2 (DN 50) and Smaller: Swing check valves.

B. Select valves, except wafer and flangeless types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends heating hot water services.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.4 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.

3.5 ADJUSTING

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

END OF SECTION

SECTION HANGERS & SUPPORTS FOR HVAC PIPING & EQUIPMENT
230529

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes hangers and supports for mechanical system piping and equipment. Also included are Roof Equipment Support Rails and Roof Curbs for duct and pipe penetrations.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

PART 2 PRODUCTS

2.1 STRUCTURAL SUPPORTS

A. Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support mechanical equipment.

B. Provide support, anchors, and sleeves compatible with atmosphere where located. For applications located in corrosive atmospheres such as chemical rooms or rooms with high moisture (LSS Building), use Stainless Steel version of hangers and supports model and type listed in this Section. All other areas shall use Galvanized Steel.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pipe Hangers:
      a) B-Line Systems, Inc.
      b) Grinnell Corp.
      c) National Pipe Hanger Corp.
   2. Channel Support Systems:
      a) B-Line Systems, Inc.
      b) Grinnell Corp.; Power-Strut Unit.
      c) National Pipe Hanger Corp.
      d) Unistrut Corp.

2.3 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
   1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
   2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
   1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
   2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

2.4 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   2. Properties: Non-staining, noncorrosive, and nongaseous.
   3. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

2.5 DUCT AND PIPE CURB ASSEMBLIES

A. Acceptable Manufacturers: The Pate Company, or equal.

B. Curb Assembly shall consist of heavy gauge galvanized steel roof curb, unitized construction, with integral base plate, 1-½” insulation and 2x2 treated wood nailer.

C. Pipe Curb: unit shall be furnished with acrylic clad thermos plastic cover, fastening screws, graduated step boots with stainless steel clamps.

D. Duct Curb: Field fabricate flashing and counter flashing around ductwork at curb penetration.

2.6 EQUIPMENT SUPPORT ROOF RAILS

A. Acceptable Manufacturers: The Pate Company or equal.

B. Roof rail equipment supports: 18 ga galvanized steel, unitized construction with integral base plate, continuous welded corner seams, pressure treated wood nailer, counter flashing with screws. Internally reinforced to conform with manufacture’s load bearing factors.

C. Provide with standard wood nailer with 1-inch overhang to allow for installation of insulation on vertical support surfaces.

D. Provide Roof Rails with Height dimension of 18-inch and length as required for equipment being supported.

PART 3 EXECUTION

3.1 GENERAL

A. Provide support, anchors, and sleeves compatible with atmosphere where located. For applications located in corrosive atmospheres such as chemical rooms or rooms with high moisture, use Stainless Steel version of hanger model and type listed in this Section. All other areas shall use Galvanized Steel.

3.2 HANGER AND SUPPORT APPLICATIONS

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

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

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

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).

D. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
3. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

E. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a) Light (MSS Type 31): 750 lb (340 kg).
   b) Medium (MSS Type 32): 1500 lb (675 kg).
   c) Heavy (MSS Type 33): 3000 lb (1350 kg).
2. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
3. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
4. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.

F. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi (690-kPa) minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

3.3 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

1. Field assemble and install according to manufacturer's written instructions.

C. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

D. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

I. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a) Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b) Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c) Do not exceed pipe stress limits according to ASME B31.9.
   2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
      a) Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a) NPS 1/4 to NPS 3-1/2 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   5. Insert Material: Length at least as long as protective shield.

3.4 EQUIPMENT SUPPORTS

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

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

3.5 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

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

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments.

3.7 PAINTING

A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal. All pipe hangers and supports are to be painted.

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

3.8 ROOF RAIL SUPPORTS & DUCT/PIPE CURB OPENINGS

A. Coordinate installation of roof rail supports and curb openings with roofing work of this project.

B. Coordinate roofing insulation installation with work of this project. Support rail frame to be insulated vertically up all sides.

END OF SECTION

SECTION IDENTIFICATION FOR HVAC SYSTEMS
230553

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Equipment markers.
   3. Pipe markers.
   4. Valve tags.
   5. Valve schedules.

1.2 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.3 COORDINATION

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

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

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

PART 2 PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a) Manufacturer, product name, model number, and serial number.
      b) Capacity, operating and power characteristics, and essential data.
      c) Labels of tested compliances.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
   1. Terminology: Match schedules as closely as possible.
   2. Data:
      a) Name and plan number.
      b) Equipment service.
      c) Design capacity.
   3. Size: 2-1/2 by 4 inches (64 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, full-band pipe markers extending 360 degrees around pipe at each location, with lettering indicating service, and showing direction of flow.
   1. Colors: Comply with ASME A13.1, unless otherwise indicated.
   2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

3. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pre-tensioned Pipe Markers: Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers, with numbering scheme. Provide 5/32-inch (4-mm) hole for fastener.
   1. Material: 0.032-inch- (0.8-mm-) thick brass or 0.0375-inch- (1-mm-) thick stainless steel.
   2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.4 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
   2. Frame: Finished hardwood or Extruded aluminum.
   3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

PART 3 EXECUTION

3.1 APPLICATIONS, GENERAL

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

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
   1. Fuel-burning units including boilers, heaters, etc.
   2. Air handling equipment
   3. Pumps and similar motor-driven units.
   4. Coils, heat recovery units, and similar equipment.
   5. Fans, blowers and primary balancing dampers.

B. Install access panel markers with screws on equipment access panels.

C. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
   1. Letter Size: Minimum 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a) Main control and operating valves, including safety devices and hazardous units such as gas outlets.
      b) Fuel-burning units including boilers, heaters, etc.
      c) Air handling equipment

d) Pumps and similar motor-driven units.
e) Coils, heat recovery units and similar equipment.
f) Fans, blowers and primary balancing dampers.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Pre-tensioned pipe markers. Use size to ensure a tight fit.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 25 feet (15 m) along each run. Reduce intervals to 15 feet (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
   1. Valve-Tag Size and Shape:
      a) All Systems: 1-1/2 inches (38 mm)round.
   2. Valve-Tag and letter Color:
      a) Conform to existing building standards.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.7 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION

SECTION TESTING, ADJUSTING & BALANCING FOR HVAC
230593

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems:
      a) Constant-volume air systems.
   2. Hydronic Piping Systems:
      a) Constant-flow systems.
      b) Primary-secondary systems.
   3. HVAC equipment quantitative-performance settings.
   4. Indoor-air quality measuring.
   5. Verifying that automatic control devices are functioning properly.
   6. Reporting results of activities and procedures specified in this Section.

1.2 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, per indicated quantities.

C. Balancing Devices: All installed devices necessary to achieve proper balancing of the system such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers.

D. NC: Noise criteria.

E. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

F. Report Forms: Test data sheets for recording test data in logical order.

G. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

H. TAB: Testing, adjusting, and balancing.

I. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

J. Test: A procedure to determine quantitative performance of systems or equipment.

K. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 SUBMITTALS

A. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

B. Warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a) Submittal distribution requirements.
   b) The Contract Documents examination report.
   c) TAB plan.
   d) Work schedule and Project-site access requirements.
   e) Coordination and cooperation of trades and subcontractors.
   f) Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.6 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems per the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Verify that balancing devices are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
   2. The TAB Firm shall review the Contract Documents and the Mechanical Contractor's shop drawings to identify any additional balancing devices that are necessary to achieve a balanced system but not shown on the drawings. Furnish and install those additional balancing devices necessary to achieve a balanced system. Coordinate with the Mechanical Contractor to properly schedule this work. Failure to coordinate installation of these devices with the Mechanical Contractor will result in absorbing all costs associated with work of other trades that is affected by modification of building components and systems. All balancing devices and installations shall comply with other Division 15 sections.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as unit heaters, to verify that they are accessible and their controls are connected and functioning.

L. Examine strainers for clean screens and proper perforations.

M. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine system pumps to ensure absence of entrained air in the suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.

4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

R. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system per the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish per insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:
   a) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b) Measure static pressure directly at the fan outlet or through the flexible connection.
   c) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
2. Measure static pressure across each component that makes up an air-handling unit and other air-handling and -treating equipment.
   a) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
   a) Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check expansion tank liquid level.
   3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
   4. Check flow-control valves for specified sequence of operation and set at indicated flow.
   5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
   6. Set system controls so automatic valves are wide open to heat exchangers.
   7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
   8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated pre-settings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system as specified above for hydronic systems.

3.10 PROCEDURES FOR MOTORS

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

3.11 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.12 PROCEDURES FOR BOILERS

A. Measure entering- and leaving-water temperatures and water flow.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Refrigerant Coils: Measure the following data for each coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.15 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.

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

3.16 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: Plus 5 to minus 10 percent.
3. Heating-Water Flow Rate: Plus 5 to minus 10 percent.

3.17 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:
    a) Indicated versus final performance.
    b) Notable characteristics of systems.
    c) Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a) Settings for outside-, return-, and exhaust-air dampers.
    b) Conditions of filters.
    c) Cooling coil, wet- and dry-bulb conditions.
    d) Fan drive settings including settings and percentage of maximum pitch diameter.
    e) Other system operating conditions that affect performance.

E. Air-Handling Equipment Test Reports: (May or may not include coils info or heat exchanger info):
1. Unit Data: Include the following:
    a) Unit identification.
    b) Location.
    c) Make and type.
    d) Model number and unit size.
    e) Manufacturer's serial number.
    f) Unit arrangement and class.
    g) Discharge arrangement.
    h) Sheave make, size in inches (mm), and bore.
    i) Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
    j) Number of belts, make, and size.
    k) Number of filters, type, and size.
2. Motor Data:
    a) Make and frame type and size.
    b) Horsepower and rpm.
    c) Volts, phase, and hertz.
    d) Full-load amperage and service factor.
    e) Sheave make, size in inches (mm), and bore.
    f) Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
3. Test Data (Indicated and Actual Values):
    a) Total airflow rate in cfm (L/s).
    b) Total system static pressure in inches wg (Pa).
    c) Fan rpm.
    d) Discharge static pressure in inches wg (Pa).
    e) Filter static-pressure differential in inches wg (Pa).
    f) Cooling coil static-pressure differential in inches wg (Pa).
    g) Heating coil static-pressure differential in inches wg (Pa).
    h) Outside airflow in cfm (L/s).
    i) Return airflow in cfm (L/s).
    j) Outside-air damper position.
    k) Return-air damper position.(kPa).

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
    a) System identification.
    b) Location.
    c) Make and type.
    d) Model number and size.
    e) Manufacturer's serial number.
    f) Arrangement and class.
    g) Sheave make, size in inches (mm), and bore.
    h) Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
2. Motor Data:
    a) Make and frame type and size.
    b) Horsepower and rpm.

c) Volts, phase, and hertz.
d) Full-load amperage and service factor.
e) Sheave make, size in inches (mm), and bore.
f) Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
g) Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
a) Total airflow rate in cfm (L/s).
b) Total system static pressure in inches wg (Pa).
c) Fan rpm.
d) Discharge static pressure in inches wg (Pa).
e) Suction static pressure in inches wg (Pa).

G. Air-Terminal-Device Reports:

1. Unit Data:
a) System and air-handling unit identification.
b) Location and zone.
c) Test apparatus used.
d) Area served.
e) Air-terminal-device make.
f) Air-terminal-device number from system diagram.
g) Air-terminal-device type and model number.
h) Air-terminal-device size.
i) Air-terminal-device effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):
a) Airflow rate in cfm (L/s).
b) Air velocity in fpm (m/s).
c) Preliminary airflow rate as needed in cfm (L/s).
d) Preliminary velocity as needed in fpm (m/s).
e) Final airflow rate in cfm (L/s).
f) Final velocity in fpm (m/s).
g) Space temperature in deg F (deg C).

H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
a) System and air-handling unit identification.
b) Location and zone.
c) Room or riser served.
d) Coil make and size.
e) Flowmeter type.

2. Test Data (Indicated and Actual Values):
a) Airflow rate in cfm (L/s).
b) Entering-water temperature in deg F (deg C).
c) Leaving-water temperature in deg F (deg C).
d) Water pressure drop in feet of head or psig (kPa).
e) Entering-air temperature in deg F (deg C).
f) Leaving-air temperature in deg F (deg C).

I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
a) Unit identification.
b) Location.
c) Service.
d) Make and size.
e) Model and serial numbers.
f) Water flow rate in gpm (L/s).
g) Water pressure differential in feet of head or psig (kPa).
h) Required net positive suction head in feet of head or psig (kPa).
i) Pump rpm.
j) Impeller diameter in inches (mm).

k) Motor make and frame size.
l) Motor horsepower and rpm.
m) Voltage at each connection.
n) Amperage for each phase.
o) Full-load amperage and service factor.
p) Seal type.

2. Test Data (Indicated and Actual Values):
a) Static head in feet of head or psig (kPa).
b) Pump shutoff pressure in feet of head or psig (kPa).
c) Actual impeller size in inches (mm).
d) Full-open flow rate in gpm (L/s).
e) Full-open pressure in feet of head or psig (kPa).
f) Final discharge pressure in feet of head or psig (kPa).
g) Final suction pressure in feet of head or psig (kPa).
h) Final total pressure in feet of head or psig (kPa).
i) Final water flow rate in gpm (L/s).
j) Voltage at each connection.
k) Amperage for each phase.

J. Boiler Test Reports:

1. Unit Data:
a) Unit identification.
b) Location.
c) Service.
d) Make and type.
e) Model and serial numbers.
f) Fuel type and input in Btuh (kW).
g) Number of passes.
h) Ignition type.
i) Burner-control types.
j) Voltage at each connection.
k) Amperage for each phase.

2. Test Data (Indicated and Actual Values):
a) Operating pressure in psig (kPa).
b) Operating temperature in deg F (deg C).
c) Entering-water temperature in deg F (deg C).
d) Leaving-water temperature in deg F (deg C).
e) Number of safety valves and sizes in NPS (DN).
f) Safety valve settings in psig (kPa).
g) High-limit setting in psig (kPa).
h) Operating-control setting.
i) High-fire set point.
j) Low-fire set point.
k) Voltage at each connection.
l) Amperage for each phase.
m) Draft fan voltage at each connection.
n) Draft fan amperage for each phase.
o) Manifold pressure in psig (kPa).

K. Air-to-Air Heat-Recovery Unit Reports:

1. Unit Data:
a) Unit identification.
b) Location.
c) Service.
d) Make and type.
e) Model and serial numbers.

2. Motor Data:
a) Make and frame type and size.
b) Horsepower and rpm.
c) Volts, phase, and hertz.

d) Full load amperage and service factor.
e) Sheave make, size in inches (mm), and bore.
f) Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).

3. If fans are an integral part of the unit, include the following for each fan:
   a) Make and type.
   b) Arrangement and size.
   c) Sheave make, size in inches (mm), and bore.
   d) Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
4. Test Data (Indicated and Actual Values):
   a) Total exhaust airflow rate in cfm (L/s).
   b) Purge exhaust airflow rate in cfm (L/s).
   c) Outside airflow rate in cfm (L/s).
   d) Total exhaust fan static pressure in inches wg (Pa).
   e) Total outside-air fan static pressure in inches wg (Pa).
   f) Pressure drop on each side of recovery wheel in inches wg (Pa).
   g) Exhaust air temperature entering in deg F (deg C).
   h) Exhaust air temperature leaving in deg F (deg C).
   i) Outside-air temperature entering in deg F (deg C).
   j) Outside-air temperature leaving in deg F (deg C).
   k) Calculate sensible and total heat capacity of each airstream in MBh (kW).

L. Instrument Calibration Reports:
1. Report Data:
   a) Instrument type and make.
   b) Serial number.
   c) Application.
   d) Dates of use.
   e) Dates of calibration.

3.19 INSPECTIONS

A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
   a) Measure airflow of at least 10 percent of air outlets.
   b) Measure water flow of at least 5 percent of terminals.
   c) Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d) Verify that balancing devices are marked with final balance position.
   e) Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

C. Additional test shall be provided as referenced above at no additional cost to owner, architect, or engineer.

END OF SECTION

SECTION HVAC DUCT INSULATION
230713

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes semi-rigid and flexible duct, and plenum insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Division 23 Section "HVAC Piping Insulation" for insulation for piping systems.
3. Division 23 Section "Metal Ducts" for duct liner.

1.2 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification and designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate clearance requirements with duct Installer for insulation application.

1.6 SCHEDULING

A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

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

1. Mineral-Fiber Insulation:

a) CertainTeed Manson.
b) Johns Manville
c) Knauf FiberGlass GmbH.
d) Owens-Corning Fiberglas Corp.

2.1 INSULATION MATERIALS

A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

2.2 ACCESSORIES AND ATTACHMENTS

A. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Aluminum: 0.007 inch thick.
3. Galvanized Steel: 0.005 inch thick.
4. Brass: 0.010 inch thick.
5. Nickle-Copper Alloy: 0.005 inch thick.

B. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

C. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.

1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.

2.3 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes per the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply multiple layers of insulation with longitudinal and end seams staggered.

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation per manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.

1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

Q. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.

1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives per manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a) On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b) On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c) Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d) Do not over compress insulation during installation.

4. Impale insulation over anchors and attach speed washers.
5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.

7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives per manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Space anchor pins as follows:

a) On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b) On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c) Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d) Do not over compress insulation during installation.

4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

B. Insulate the following plenums and duct systems:

1. Indoor concealed supply-, return-, exhaust- and outside-air ductwork.
2. Indoor exposed supply-, return-, exhaust- and outside-air ductwork.

C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Metal ducts with duct liner providing equivalent insulation values.
2. Exposed metal ducts in the Elephant Bedrooms and Dayroom, Hay Storage 105, Work Rooms 101 & 102 and Hoofstock Holding Building.
3. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
4. Factory-insulated flexible ducts.
5. Vibration-control devices.
6. Testing agency labels and stamps.

7. Nameplates and data plates.
8. Access panels and doors in air-distribution systems.
9. Flexible Connectors.

3.6 INDOOR DUCT APPLICATION SCHEDULE

A. Service: All Supply-air, Return-air and Outside air ducts, concealed and Concealed Exhaust air ducts (within the first 6 feet of building envelop penetration).

1. Material: Mineral-fiber blanket with FSK jacket
2. Thickness: 1-1/2 inches.
3. Number of Layers: One.
4. Vapor Retarder Required: Yes.
5. Installed insulation value minimum: R-6

B. Service: All Supply-air, Return-air and Outside air ducts, exposed and Exposed Exhaust air ducts (within the first 6 feet of building envelop penetration).

1. Material: Mineral-fiber board with FSK jacket
2. Thickness: 1-1/2 inches (50 mm).
3. Number of Layers: Two.
4. Vapor Retarder Required: Yes.
5. Installed insulation value minimum: R-8

END OF SECTION

SECTION HVAC PIPING INSULATION
230719

PART 1 GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Condensate drain piping.
   2. Heating hot-water piping.
   3. Refrigerant suction and hot-gas piping.

B. Related Sections:
   1. Division 23 "HVAC Duct Insulation."

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

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

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

B. Protect insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation; remove it from the project site.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 "Hangers and Supports for HVAC systems."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General" article for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

    a) Aeroflex USA, Inc.; Aerocel.
    b) Armacell LLC; AP Armaflex.
    c) K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
    a) Johns Manville; Micro-Lok.
    b) Knauf Insulation; 1000-Degree Pipe Insulation.
    c) Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
    a) CertainTeed Corp.; CrimpWrap.
    b) Johns Manville; MicroFlex.
    c) Knauf Insulation; Pipe and Tank Insulation.
    d) Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
2. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
4. Color: White.

2.6 SEALANTS

A. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.

3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.
5. VOC limit for indoor applications:420 g/L.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.
5. VOC limit for indoor applications: 420 g/L.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
a) Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
6.

2.10 SECUREMENTS

A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 3/4 inch (13 mm) (19 mm) wide with wing seal or closed seal.

2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 13/4 inch (13 mm) (19 mm) wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy (1.6-mm).

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) (100 mm) o.c.
      a) For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

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

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 07 84 00" Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 00 " Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket..

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When pre-formed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

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

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

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated and all areas with washdown activities, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal watertight with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.9 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a) Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   1. Insulation Material: Mineral fiber.
   2. Insulation Thickness: 1/2 inch minimum.
   3. Factory Applied Jacket: ASJ-SSL.
   4. Field-Applied Jacket: PVC on exposed piping in mechanical rooms or within 10 ft of floor in occupied spaces

5. Vapor Barrier Required: Yes

B. Hot Water above 140 Deg F (60 Deg C):
   1. Insulation Material: Mineral fiber.
   2. Insulation Thickness:
      a) NPS 1-1/4 and smaller: 1-1/2 inch minimum.
      b) NPS 1-1/2 and larger: 2 inch minimum.
   3. Factory Applied Jacket: ASJ-SSL.
   4. Field-Applied Jacket: PVC on exposed piping (Note All areas will be subject to washdown activities).
   5. Vapor Barrier Required: No

C. Hot Water, 140 Deg F (60 Deg C) and below:
   1. Insulation Material: Mineral fiber.
   2. Insulation Thickness:
      a) NPS 1-1/4 and smaller: 1 inch minimum.
      b) NPS 1-1/2 and larger: 1-1/2 inch minimum.
   3. Factory Applied Jacket: ASJ-SSL.
   4. Field-Applied Jacket: PVC on all exposed piping (Note All areas will be subject to washdown activities).
   5. Vapor Barrier Required: No

D. Refrigerant Suction and Hot-Gas Piping and Flexible Tubing:
   1. Insulation Material: Flexible elastomeric.
   2. Insulation Thickness: 1 inch minimum.
   3. Factory Applied Jacket: None.
   4. Field-Applied Jacket: None.
   5. Vapor Barrier Required: No

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping and Flexible Tubing:
   1. Insulation Material: Flexible elastomeric.
   2. Insulation Thickness: 1-1/2 inch minimum.
   3. Factory Applied Jacket: None.
   4. Field-Applied Jacket: UV Protective Coating (Latex Paint – 2 coats minimum. Color to blend into surroundings).
   5. Vapor Barrier Required: No

3.14 OUTDOOR, BELOWGROUND PIPING INSULATION SCHEDULE

A. Refer to Division 23 Section “Radiant Heating Hydronic piping” for underground piping insulation.

END OF SECTION

SECTION 23 09 13
230913

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Section 23 05 19 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Section 23 09 23 "Direct-Digital Control System for HVAC" for requirements that relate to this Section.
3. Section 23 09 93 “Sequence of Operations for HVAC Controls” for requirements that relate to this Section.

1.2 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

a) Water Temperature: Plus or minus 1 deg F (0.5 deg C).
b) Water Pressure: Plus or minus 2 percent of full scale.
c) Space Temperature: Plus or minus 1 deg F (0.5 deg C).
d) Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
e) Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
f) Electrical: Plus or minus 5 percent of reading.

1.3 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Schedule of valves including flow characteristics.

1.4 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Operation and Maintenance Data: For HVAC instrumentation and control devices to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 00 "Closeout Submittals," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ASHRAE 135 for DDC system components.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

1.7 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details and Architect before installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

B. All devices to be connected to the existing Zoo campus BAS shall be compatible with Johnson Controls Metasys controllers.

2.3 ANALOG CONTROLLERS

A. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.

B. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

C. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.4 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:

a) BEC Controls Corporation.
b) Ebtron, Inc.

c) Heat-Timer Corporation.
d) I.T.M. Instruments Inc.
e) MAMAC Systems, Inc.
f) RDF Corporation.

2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

2.5 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.

C. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.6 THERMOSTATS

A. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

C. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

D. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

2.7 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

a) Belimo Aircontrols (USA), Inc.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

a) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
b) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
c) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
11. Run Time: 12 seconds open, 5 seconds closed.

2.8 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

a) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
b) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

3. Sizing: 5-psig (35-kPa maximum pressure drop at design flow rate or the following:

a) Two Position: Line size.
b) Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
c) Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
5. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

C. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.9 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Section 27 15 00 "Communications Horizontal Cabling."

PART 3 EXECUTION

3.1 INSTALLATION

A. Connect and configure equipment to achieve sequence of operation specified.

B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details and Architect before installation.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

C. Install guards on thermostats in the following locations:

1. Public areas.
2. Where indicated.

D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

E. Install labels and nameplates to identify control components according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

F. Install hydronic instrument wells, valves, and other accessories according to Section 23 21 13 "Hydronic Piping."

G. Install electronic and fiber-optic cables according to Section 27 15 00 "Communications Horizontal Cabling."

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Section 27 15 00 "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each system for compliance with sequence of operation.
5. Test hardware interlocks.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
   a) Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:
   a) Manually operate flow switches to verify that they make or break contact.

6. Pressure:

   a) Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b) Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:
   a) Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 01 77 00 "Closeout Procedures."

END OF SECTION

SECTION 230923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a complete Direct Digital Control (DDC) system. This system interfaced with electric controls specified in Section 23 09 13 “Instrumentation and Control Devices for HVAC” utilizing Direct Digital Control signals to operate actuated control devices will meet, in every respect, all operational and quality standards specified herein.

B. Controls system shall be an extension of the existing facility Johnson Controls Metasys system. New equipment shall be compatible with existing control system.

C. Related Sections include the following:

1. Section 23 05 19 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
2. Section 23 09 13 “Instrumentation and Control Devices for HVAC” for electric control equipment and devices.
3. Section 23 09 93 “Sequence of Operations for HVAC Controls” for control requirements.

1.2 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. MS/TP: Master slave/token passing.

D. PID: Proportional plus integral plus derivative.

1.3 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a) Water Temperature: Plus or minus 1 deg F (0.5 deg C).
    b) Water Flow: Plus or minus 5 percent of full scale.
    c) Water Pressure: Plus or minus 2 percent of full scale.
    d) Space Temperature: Plus or minus 1 deg F (0.5 deg C).
    e) Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
    f) Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
    g) Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).

h) Relative Humidity: Plus or minus 5 percent.
i) Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
j) Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
k) Carbon Dioxide: Plus or minus 50 ppm.
l) Electrical: Plus or minus 5 percent of reading.

1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for interface equipment, control units, transducers/transmitters, sensors, relays/switches, control panels, and operator interface equipment.
   2. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Written description of sequence of operation.
   6. Schedule of dampers including size, leakage, and flow characteristics.
   7. DDC System Hardware:
      a) Wiring diagrams for control units with termination numbers.
      b) Schematic diagrams and floor plans for field sensors and control hardware.
      c) Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   9. Controlled Systems:
      a) Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      b) Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      c) Written description of sequence of operation including schematic diagram.
      d) Points list.

1.5 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Qualification Data: For Installer.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

D. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 00 "Closeout Submittals," include the following:

1. Interconnection wiring diagrams with identified and numbered system components and devices.
2. Keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Calibration records and list of set points.

B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by Johnson Controls, Inc.; Metasys.

2.2 CONTROL SYSTEM

A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An existing operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a) Global communications.
    b) Discrete/digital, analog, and pulse I/O.

c) Monitoring, controlling, or addressing data points.
d) Software applications, scheduling, and alarm processing.
e) Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

a) Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
b) HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
c) Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
d) Remote communications.
e) Maintenance management.
f) Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a) Global communications.
b) Discrete/digital, analog, and pulse I/O.
c) Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
   1. Minimum dielectric strength of 1000 V.
   2. Maximum response time of 10 nanoseconds.
   3. Minimum transverse-mode noise attenuation of 65 dB.
   4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
   1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
   2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
   3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
   4. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).

2.5 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
   1. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) (0.2 deg C) at calibration point.
   2. Wire: Twisted, shielded-pair cable.
   3. Insertion Elements in Ducts: Single point, 8 inches (200 mm) (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
   4. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
   5. Room Sensor Cover Construction: Manufacturer's standard locking covers.
      a) Set-Point Adjustment: Exposed.
      b) Set-Point Indication: Exposed.
      c) Space Temperature Indication: Exposed.
   6. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
   7. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

2.6 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Section 27 15 00 "Communications Horizontal Cabling."

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 INSTALLATION

A. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Verify location of thermostats, humidistats, and other exposed control sensors with Architect before installation.

C. Install security sensors with stainless steel cover plates in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

D. Connect and configure equipment and software to achieve sequence of operation specified.

E. Install labels and nameplates to identify control components according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

F. Install electronic and fiber-optic cables according to Section 27 15 00 "Communications Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."

B. Install building wire and cable according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Section 27 15 00 "Communications Horizontal Cabling."
1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect**,** test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
7. Check temperature instruments and material and length of sensing elements.
8. Check control valves. Verify that they are in correct direction.
9. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
10. Check DDC system as follows:

    a) Verify that DDC controller power supply is from emergency power supply, if applicable.
    b) Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c) Verify that spare I/O capacity has been provided.
    d) Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a) Check analog inputs at 0, 50, and 100 percent of span.
    b) Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c) Check digital inputs using jumper wire.
    d) Check digital outputs using ohmmeter to test for contact making or breaking.
    e) Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:

1. Section 23 09 00 "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

2. Section 23 09 23 “Direct-Digital Control System for HVAC”.

1.2 DEFINITIONS

A. DDC: Direct digital control.

1.3 ELEPHANT BUILDING

A. Hot Water Heating System:
   1. Boiler B-1
      a. Boiler shall run on demand from radiant floor system or hot water radiators system. Boiler controller shall modulate burner to maintain supply water set point temperature (130 deg F, adjustable).
   2. Radiator Pump P-1
      a. Radiators shall be interlocked with RTU-1. When RTU-1 is in heating mode, enable pump and modulate 3-way control valve to maintain space set point temperature. When RTU-1 is in cooling or economizer mode, pump shall be off.
   3. Radiant Floor Pump P-2.
      a. Enable pump on demand for heating from radiant floor system. Modulate three-way control valve to maintain pressure differential set point.

B. Elephant Area and First Floor Public Area Heating and Ventilation:
   1. Energy Recovery Unit ERU-1.
      a. Run continuously during heating mode. Dampers shall be open.
      b. Modulate burner to maintain space set point temperature (55 deg F, adjustable).
      c. Unit shall be off during cooling mode. Dampers shall be closed.
      d. On smoke detection, unit shall shut down.
   2. Exhaust Fans EF-6, EF-7, EF-8 (barn).
      a. Interlock with space garage doors. On demand for cooling, if garage doors are open, open fan dampers and enable fans. When fans are off, fan dampers shall be fully closed.
   3. Exhaust Fan EF-4 (public restrooms).
      a. Unit shall run continuously during occupied mode.
   4. Gas-Fired Infrared Heaters
      a. System shall enable infrared heaters to maintain floor slab temperature set point (?? Deg F, adjustable)

C. Second Floor Public Area Heating, Cooling and Ventilation:
   1. Rooftop Unit RTU-1 (single zone VAV).
      a. Fan shall run continuously during occupied mode. Provide wall-mounted push-button to enable occupied mode. TIMER? Fan shall cycle as needed to maintain space setback temperature.
      b. Heating mode. stage burners to maintain space set point temperature

c. Cooling mode: stage compressors and vary fan speed to maintain space set point temperature.
d. Ventilation Control: During occupied modulate outside air and return air dampers from minimum outside air position to maximum position proportional to space CO2.
1) 500 ppm (adjustable): Outside air at minimum position
2) 1100 ppm (adjustable): Outside air damper at maximum position.
3) During unoccupied mode, outside air damper shall be fully closed and return air damper shall be fully open.
e. Economizer: On call for cooling when outside air temperature is 65 deg F (adjustable) or lower, disable compressors and modulate outside air and return air dampers to maintain space temperature. Outside air damper minimum positions shall be determined by space ventilation requirements (CO2).
f. Dehumidification cycle: During cooling mode, unit shall enable compressors and hot gas bypass as required to maintain space humidity set point.

2. Exhaust Fan EF-5.
a. Interlock fan with RTU-1. Fan shall run and fan dampers shall open when RTU-1 is in occupied mode. When RTU-1 is in unoccupied mode, fan shall be off and fan damper shall be fully closed.

D. Lobby Heating and Cooling:
1. Rooftop Unit RTU-2.
a. Fan shall run continuously.
b. Heating mode. stage burners to maintain space set point temperature
c. Cooling mode: stage compressors and vary fan speed to maintain space set point temperature.
d. Ventilation Control: Modulate outside air and return air dampers to maintain positive space pressure of 0.02 inch wc (adjustable)
e. Economizer: On call for cooling when outside air temperature is 65 deg F (adjustable) or lower, disable compressors and modulate outside air and return air dampers to maintain space temperature. Outside air damper minimum positions shall be determined by space ventilation requirements (CO2).

E. Keeper Area Heating, Cooling and Ventilation:
1. Gas-Fired Furnace GFF-1, Air-Cooled Condensing Unit ACC-1 Exhaust Fan EF-3.
a. Fan shall run continuously during occupied mode (schedule set by BAS).
b. Fan shall cycle as needed during unoccupied mode to maintain space setback temperature.
c. Furnace controller shall modulate burner or enable ACC-1 to maintain space set point temperature.
d. Ventilation Control: Unit shall be interlocked with exhaust fan EF-3. Space occupancy sensors in each toilet room shall enable fan to run. Fan shall run for 15 minutes (adjustable) after occupancy sensor registers no signal.

F. Additional Cooling Systems:
1. Electrical Room Split System DSS-3
a. Split system controller shall enable cooling mode to maintain space set point temperature (80 deg F, adjustable).

G. Additional Ventilation Systems:
1. Hay Storage Exhaust EF-1: Unit shall be interlocked with louver OAL-1. Wall switch shall enable fan. When fan is on, OAL-1 and fan damper shall be open. When fan is off, OAL-1 and fan damper shall be closed.
2. Food Storage Exhaust Fan EF-2

H. Additional Heating Systems:
1. Electric Wall Heaters/Electric Baseboard Heaters:
a. Integral thermostats enable heaters to maintain space temperature.

1.4 LSS BUILDING

A. Main Heating and Ventilation: System shall enable electric unit heaters and exhaust fan to maintain space temperature.
   1. Heating mode: System shall cycle electric Unit Heaters EUH-1, EUH-2, EUH-3 to maintain space heating set point temperature. Exhaust fan EF-12 shall be off.
   2. Cooling/Ventilation mode: System shall cycle EF-12 to maintain space cooling set point temperature. EUH-1, EUH-2 and EUH-3 shall be off.

B. Chemical Rooms Heating and Ventilation:
   1. Electric Unit Heaters EUH-4, EUH-5: integral thermostat shall cycle unit heaters to maintain space temperature.
   2. Exhaust Fan EF-9, EF-10: Fans shall run continuously.

C. Ozone Rooms Heating, Cooling and Ventilation:
   1. Ductless Split System DSS-1.
      a. Split system controller shall enable heating or cooling mode to maintain space set point temperature.
   2. Exhaust Fan EF-11 Fans shall run continuously while ozone system is active.

D. Outside Air Louver OAL-2: Interlock louver with EF-11 and EF-12.
   1. When both EF-11 and EF-12 are off, damper shall be fully closed.
   2. When both EF-11 and EF-12 are on, damper shall be fully open.
   3. When only one fan is on, damper shall be open to minimum position.

1.5 HOOFSTOCK BUILDING

A. Main Heating and Ventilation:
   1. Existing air handling unit.
      a. Fan shall run continuously during heating mode.
      b. System shall modulate hot water control valve to maintain space set point temperature (55 deg F, adjustable).
      c. Unit shall be off during cooling mode.
      d. On smoke detection, unit shall shut down.
   2. Exhaust Fan EF-13.
      a. Interlock with outside air louvers OAL-3 and OAL-4. On demand for cooling, open louver dampers and fan damper and enable fan. When fan is off, fan damper and louver dampers shall be fully closed.
   3. Electric-Fired Infrared Heaters
      a. System shall enable infrared heaters to maintain floor slab temperature set point (?? Deg F, adjustable)

B. Office Heating, Cooling and Ventilation
   1. Ductless Split System DSS-2.
      a. Supply fan shall run continuously during occupied mode. Split system controller shall enable heating or cooling mode to maintain space set point temperature.

1.6 SHADE STRUCTURES

A. Heating and Ventilation: Infrared heaters and fans shall be enabled via a manual switch in control panel located in Elephant Building (verify location). Interlock control of heaters and fans to prevent both systems from running simultaneously.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

PART 4 - POINTS LISTS

4.1 Hot Water System

POINT		ANALOG INPUT	ANALOG OUTPUT	BINARY INPUT	BINARY OUTPUT	GRAPHICS SCREEN	SOFTWARE POINT
HOT WATER BOILER							
	STATUS			●		●	
	ENABLE TEMP SETPOINT					●	●
	ENABLE/DISABLE				●		
	EMERGENCY CUT-OFF SWITCH			●			
	FIRING RATE					●	
	HOT WATER SUPPLY TEMP SETPOINT		●			●	
	HOT WATER SUPPLY TEMP	●				●	
	HOT WATER RETURN TEMP	●				●	
	BURNER RUNTIME					●	●
	BURNER CYCLES					●	●
	BOILER ALARM			●		●	
RADIANT FLOOR PUMP							
	STATUS			●		●	
	START/STOP				●	●	
	SYSTEM PRESSURE SETPOINT					●	●
	SYSTEM PRESSURE	●				●	
	RETURN TEMP	●				●	
PERIMETER HEATING PUMP							
	STATUS			●		●	
	START/STOP				●	●	
	RETURN TEMP	●				●	

4.2 Elephant Area Systems

POINT		ANALOG INPUT	ANALOG OUTPUT	BINARY INPUT	BINARY OUTPUT	GRAPHICS SCREEN	SOFTWARE POINT
GENERAL							
	OUTDOOR AIR TEMPERATURE					●	●
	SPACE SET POINT TEMPERATURE					●	●
	SPACE TEMPERATURE	●				●	
	SPACE TEMP LOW LIMT SET POINT					●	●
	SPACE TEMP LOW LIMT ALARM					●	●
ENERGY RECOVERY UNIT							
	UNIT ENABLE				●	●	
	SUPPLY FAN STATUS			●		●	
	EXHAUST FAN STATUS				●	●	
	BURNER FIRING RATE	●				●	
	OUTSDIE AIR DAMPER POSITION	●				●	
	EXHAUST AIR DAMPER POSITION	●				●	
	FRESH AIR ENTERING TEMPERATURE	●				●	
	FRESH AIR LEAVING (SUPPLY) TEMP	●				●	

	EXHAUST AIR ENTERING TEMPERATURE	●				●	
	EXHAUST AIR LEAVING TEMPERATURE	●				●	
	FILTER PRESSURE DIFFERENTIAL	●				●	
	UNIT ALARM			●		●	
	DUCT SMOKE DETECTOR ALARM			●		●	
EXHAUST FANS (EACH FAN)							
	STATUS			●		●	
	START/STOP				●	●	
	DAMPER POSITION			●	●	●	
	GARAGE DOOR POSITION			●		●	
INFRARED HEATERS (EACH HEATER)							
	STATUS			●		●	
	UNIT ENABLE				●	●	
	FLOOR SLAB TEMP SET POINT					●	●
	FLOOR SLAB TEMP			●		●	

4.3 Elephant Building Second Floor Public Area

POINT		ANALOG INPUT	ANALOG OUTPUT	BINARY INPUT	BINARY OUTPUT	GRAPHICS SCREEN	SOFTWARE POINT
GENERAL							
	OUTDOOR AIR TEMPERATURE					●	●
	SPACE SET POINT HUMIDITY					●	●
	SPACE HUMIDITY	●				●	
	SPACE LOW CO2 SET POINT					●	●
	SPACE HIGH CO2 SET POINT					●	●
	SPACE CO2	●				●	
	SPACE SET POINT TEMPERATURE					●	●
	SPACE TEMPERATURE	●				●	
	SPACE TEMP LOW LIMT SET POINT					●	●
	SPACE TEMP LOW LIMT ALARM					●	●
ROOFTOP UNIT (SOFTWARE POINTS FROM FACTORY-INSTALLED RTU CONTROLLER)							
	UNIT ENABLE				●	●	
	SUPPLY FAN STATUS					●	●
	COMPRESSOR STATUS				●	●	●
	BURNER FIRING RATE					●	●
	OUTSDIE AIR DAMPER POSITION					●	●
	EXHAUST AIR DAMPER POSITION					●	●
	FRESH AIR ENTERING TEMPERATURE					●	●
	HOT GAS BYPASS STATUS					●	●
	UNIT DISCHARGE AIR TEMPERATURE					●	●
	UNIT ALARM					●	●
	DUCT SMOKE DETECTOR ALARM			●		●	
EXHAUST FAN							

	STATUS			●		●	
	START/STOP				●	●	
	DAMPER POSITION			●	●	●	

4.4 Stair/Lobby

POINT		ANALOG INPUT	ANALOG OUTPUT	BINARY INPUT	BINARY OUTPUT	GRAPHICS SCREEN	SOFTWARE POINT
GENERAL							
	OUTDOOR AIR TEMPERATURE					●	●
	SPACE PRESSURE SET POINT					●	●
	SPACE PRESSURE	●				●	
	SPACE SET POINT TEMPERATURE					●	●
	SPACE TEMPERATURE	●				●	
	SPACE TEMP LOW LIMT SET POINT					●	●
	SPACE TEMP LOW LIMT ALARM					●	●
ROOFTOP UNIT (SOFTWARE POINTS FROM FACTORY-INSTALLED RTU CONTROLLER)							
	UNIT ENABLE				●	●	
	SUPPLY FAN STATUS					●	●
	COMPRESSOR STATUS				●	●	●
	BURNER FIRING RATE					●	●
	OUTSDIE AIR DAMPER POSITION	●				●	
	EXHAUST AIR DAMPER POSITION	●				●	
	FRESH AIR ENTERING TEMPERATURE					●	●
	UNIT DISCHARGE AIR TEMPERATURE					●	●
	UNIT ALARM					●	●
	DUCT SMOKE DETECTOR ALARM			●		●	

4.5 Keeper Area

POINT		ANALOG INPUT	ANALOG OUTPUT	BINARY INPUT	BINARY OUTPUT	GRAPHICS SCREEN	SOFTWARE POINT
GENERAL							
	OUTDOOR AIR TEMPERATURE					●	●
	SPACE SET POINT TEMPERATURE					●	●
	SPACE TEMPERATURE	●				●	
	SPACE TEMP LOW LIMT SET POINT					●	●
	SPACE TEMP LOW LIMT ALARM					●	●
FURNACE AND CONDENSING UNIT (SOFTWARE POINTS FROM NETWORK THERMOSTAT)							
	SPACE TEMPERATURE					●	●
	SYSTEM MODE (HEAITNG, COOLING, VENT)					●	●
	SYSTEM STATUS (ON, OFF)					●	●
EXHAUST FAN							

	WOMEN'S ROOM OCCUPANCY SENSOR			●		●	
	MEN'S ROOM OCCUPANCY SENSOR			●		●	
	STATUS			●		●	
	ENABLE				●	●	
	FAN DAMPER POSITION			●	●	●	
	OUTDOOR AIR DAMPER POSITION			●	●	●	

4.6 Other Elephant Building Systems

POINT		ANALOG INPUT	ANALOG OUTPUT	BINARY INPUT	BINARY OUTPUT	GRAPHICS SCREEN	SOFTWARE POINT
ELECTRICAL ROOM COOLING SYSTEM (SOFTWARE POINTS FROM MANUFACTURER'S SPLIT SYSTEM CONTROLLER)							
	SYSTEM ENABLE				●	●	
	SPACE TEMPERATURE SET POINT					●	●
	SPACE TEMPERATURE					●	●
	SYSTEM MODE (HEAITNG, COOLING, VENT)					●	●
	SYSTEM STATUS (ON, OFF)					●	●
	ALARM					●	●
EXHAUST FANS (HAY STORAGE AND FOOD STORAGE)							
	STATUS			●		●	
	ENABLE				●	●	
	FAN DAMPER POSITION			●	●	●	
	OUTDOOR AIR DAMPER POSITION			●	●	●	

4.7 LSS Building Systems

POINT		ANALOG INPUT	ANALOG OUTPUT	BINARY INPUT	BINARY OUTPUT	GRAPHICS SCREEN	SOFTWARE POINT
GENERAL							
	SPACE TEMP HEATING SET POINT					●	●
	SPACE TEMP COOLING SET POINT					●	●
	SPACE TEMPERATURE	●				●	
	SPACE LOW LIMIT TEMPERATURE					●	●
	SPACE TEMPERATURE ALARM	●				●	
UNIT HEATERS (EACH HEATER)							
	STATUS			●		●	
	ENABLE				●	●	
EXHAUST FANS (EACH FAN)							
	STATUS			●		●	
	ENABLE				●	●	
	FAN DAMPER POSITION			●	●	●	
	OUTDOOR AIR DAMPER POSITION	●			●	●	
OZONE ROOM COOLING SYSTEM (SOFTWARE POINTS FROM MANUFACTURER'S SPLIT SYSTEM CONTROLLER)							

	SYSTEM ENABLE				●	●	
	SPACE TEMPERATURE SET POINT					●	●
	SPACE TEMPERATURE					●	●
	SYSTEM MODE (HEAITNG, COOLING, VENT)					●	●
	SYSTEM STATUS (ON, OFF)					●	●
	ALARM					●	●

4.8 Hoofstock Building Systems

A.

POINT		ANALOG INPUT	ANALOG OUTPUT	BINARY INPUT	BINARY OUTPUT	GRAPHICS SCREEN	SOFTWARE POINT
GENERAL							
	SPACE TEMP HEATING SET POINT					●	●
	SPACE TEMP COOLING SET POINT					●	●
	SPACE TEMPERATURE	●				●	
	SPACE LOW LIMIT TEMPERATURE					●	●
	SPACE TEMPERATURE ALARM	●				●	
INFRARED HEATERS (EACH HEATER)							
	STATUS			●		●	
	ENABLE				●	●	
EXHAUST FANS (EACH FAN)							
	STATUS			●		●	
	ENABLE				●	●	
	FAN DAMPER POSITION			●	●	●	
	OUTDOOR AIR DAMPER POSITION	●			●	●	
OFFICE SPLIT SYSTEM (SOFTWARE POINTS FROM MANUFACTURER'S SPLIT SYSTEM CONTROLLER)							
	SYSTEM ENABLE				●	●	
	SPACE TEMPERATURE SET POINT					●	●
	SPACE TEMPERATURE					●	●
	SYSTEM MODE (HEAITNG, COOLING, VENT)					●	●
	SYSTEM STATUS (ON, OFF)					●	●
	ALARM					●	●

B. Modify existing points list for existing air handling unit to eliminate points for cooling and associated condensing unit.

END OF SECTION

SECTION HYDRONIC PIPING & SPECIALTIES
232113 AND SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating piping.
   2. Makeup-water piping.
   3. Condensate-drain piping.
   4. Specialties
   5. Hydronic system chemical treatment / Heat transfer fluid

B. Related Sections include the following:
   1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air control devices.
   3. Hydronic specialties.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators per AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators per ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

2.3 MALLEABLE-IRON UNIONS: ASME B16.39; CLASSES 150, 250, AND 300 AS INDICATED IN PART 3 "PIPING APPLICATIONS" ARTICLE.

A. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

C. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

D. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 PLASTIC PIPE AND FITTINGS

A. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.

B. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   a) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: ASSE 1079; factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

D. Dielectric Flanges: ASSE 1079; factory-fabricated, bolted, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face-neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

F. Dielectric Nipples: IAPMO PS 66; electroplated steel nipple complying with ASTM F 1545 with inert and noncorrosive, propylene lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.7 VALVES

A. Globe, Check and Ball Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Armstrong Pumps, Inc.
   b) Bell & Gossett Domestic Pump; a division of ITT Industries.
   c) Griswold Controls.
   d) Taco.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Armstrong Pumps, Inc.
   b) Bell & Gossett Domestic Pump; a division of ITT Industries.
   c) Griswold Controls.
   d) Taco.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig (860 kPa).
11. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Diaphragm-Operated Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) Amtrol, Inc.
   b) Armstrong Pumps, Inc.
   c) Bell & Gossett Domestic Pump; a division of ITT Industries.
   d) Conbraco Industries, Inc.
   e) Spence Engineering Company, Inc.

f) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.8 AIR CONTROL DEVICES

A. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

B. Automatic Air Vents:
1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

C. Diaphragm-Type Expansion Tanks:
1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. In-line Air Separators:
1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig (1207 kPa).
3. Maximum Operating Temperature: Up to 300 deg F (149 deg C).

2.9 CHEMICAL TREATMENT/HEAT TRANSFER FLUID & HAND PUMP TRANSFER SYSTEM

A. Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

B. DowFrost HD combined anti-freeze and inhibitor or equal
1. Contains mono-propylene glycol.
2. Physical Properties:
a) Color: Bright Yellow.
b) Odor: Mild.
c) Form: Liquid.
d) ph (50% soln): 9.5-10.5.
e) Conductivity (40% soln): 0.238 btu/(hr*ft2)(degree F/ft).
f) Density (40% soln): 63.09 lb/ft3 at 180 degree F.

C. Fluid to be suitable for protecting heating systems containing mixed metals including aluminum.

D. Concentration to be 30%. Protection to be down to 0 deg F.

E. Provide hand pump for pumping from barrel container into closed pipe hydronic system.

2.10 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
   3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig (860 kPa).

B. Stainless-Steel Bellow, Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4-inch (20-mm) misalignment.
   4. CWP Rating: 150 psig (1035 kPa).
   5. Maximum Operating Temperature: 250 deg F (121 deg C).

C. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, shall be either of the following:
   1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

B. Hot-water heating piping, belowground:
   1. Refer to Division 23 Specification “Radiant Heating Hydronic Piping” for below ground piping.

C. Makeup-water piping installed aboveground shall be the following:
   1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Condensate-Drain Piping shall be any of the following:
   1. Type , drawn-temper copper tubing, wrought-copper fittings, and soldered joints
   2. Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install throttling-duty valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping**,** NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blow off connection for strainers smaller than NPS 2 (DN 50).

S. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Common Work Results for HVAC."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.

2. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
   2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
   3. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
   4. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
   2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
   3. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
   4. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).

E. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings per the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints per ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

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

F. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings per the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Non-Pressure Piping: Join per ASTM D 2855.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections per Division 23 Section "Meters and Gages for HVAC Piping."

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping per ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup pressure-reducing valves for required system pressure.
   4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   5. Set temperature controls so all coils are calling for full flow.
   6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
   7. Verify lubrication of motors and bearings.

3.9 SPARE DRUM AND FLUID

A. Provide partially empty spare drum of 35% Propylene Glycol solution with hand pump capable of periodic manual charging of glycol into system. Coordinate with owner.

END OF SECTION

SECTION HYDRONIC PUMPS
232123

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Close-coupled, in-line centrifugal pumps.

1.2 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

1.4 CLOSEOUT SUBMITTALS

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. ITT Corporation; Bell & Gossett.
   2. Armstrong Pumps Inc.
   3. Gundfos Pumps.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

B. Pump Construction:
   1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
   3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
   4. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
   5. Pump Bearings: Permanently lubricated ball bearings.

C. Motor: Single speed and rigidly mounted to pump casing.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

3. Enclosure: Open, dripproof.
4. Enclosure Materials: Cast iron.
5. Motor Bearings: Permanently lubricated ball bearings.
6. Efficiency: Premium efficient.
7. Motor shall be inverter duty rated and provided with grounding rings.

D. Capacities and Characteristics:
   1. Refer to Drawings additional information

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.

3.3 ALIGNMENT

A. Comply with pump and coupling manufacturers' written instructions.

3.4 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install triple-duty valve on discharge side of pumps.

E. Install Y-type strainer or suction diffuser as indicated and shutoff valve on suction side of pumps.

F. Install pressure gage on pump differential line.

G. Ground equipment per Section 26 "Grounding and Bonding for Electrical Systems."

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup checks for each pump before starting:
      a) Verify bearing lubrication.

b) Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c) Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 232923
VARIABLE-FREQUENCY DRIVES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. CPT: Control power transformer.

C. EMI: Electromagnetic interference.

D. IGBT: Insulated-gate bipolar transistor.

E. LAN: Local area network.

F. LED: Light-emitting diode.

G. MCP: Motor-circuit protector.

H. NC: Normally closed.

I. NO: Normally open.

J. OCPD: Overcurrent protective device.

K. PCC: Point of common coupling.

L. PID: Control action, proportional plus integral plus derivative.

M. PWM: Pulse-width modulated.

N. RFI: Radio-frequency interference.

O. TDD: Total demand (harmonic current) distortion.

P. THD(V): Total harmonic voltage demand.

Q. VFD: Variable-frequency drive.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

1. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
3. Humidity: Less than 95 percent (noncondensing).
4. Altitude: Not exceeding 3300 feet (1005 m).

1.8 COORDINATION

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

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

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs 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. ABB.
2. Eaton
3. Siemens

B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."

2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
7. Ambient Temperature Rating: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
8. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: Not exceeding 3300 feet (1005 m).
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
14. Speed Regulation: Plus or minus 5 percent.
15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
3. NC alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    a) Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).

9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
   a) A minimum of two programmable analog inputs: 0- to 10-V dc .
   b) A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
   a) 0- to 10-V dc.
   b) Potentiometer using up/down digital inputs.
   c) Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc), which can be configured for any of the following:
   a) Output frequency (Hz).
   b) Output current (load).
   c) DC-link voltage (V dc).
   d) Motor torque (percent).
   e) Motor speed (rpm).
   f) Set point frequency (Hz).
4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a) Motor running.
   b) Set point speed reached.
   c) Fault and warning indication (overtemperature or overcurrent).
   d) PID high- or low-speed limits reached.

F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: Ethernet and RS-422/485.
2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet; protocols accessible via the communications ports.

2.3 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.

3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type.
   a) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   b) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

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

3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFD to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.3 INSTALLATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFD.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
   a) Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFD. Remove front panels so joints and connections are accessible to portable scanner.
   b) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFD 11 months after date of Substantial Completion.
   c) Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFDs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

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

END OF SECTION

SECTION METAL DUCTS
233113

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 3-inch wg (minus 500 to plus 2500 Pa). Metal ducts include the following:

1. Rectangular ducts and fittings.
   a) Galvanized
   b) Stainless Steel
2. Single-wall, round and flat-oval spiral-seam ducts and formed fittings.

B. Related Sections include the following:

1. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.3 SUBMITTALS

A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot (1:50) (1:100) scale. Show fabrication and installation details for metal ducts.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Fittings.
5. Seam and joint construction.
6. Penetrations through fire-rated and other partitions.
7. Equipment installation based on equipment being used on Project.
8. Duct accessories, including access doors and panels.

1.4 QUALITY ASSURANCE

A. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 **(Z180)**coating designation; G90 coating for Holding Building; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel Ducts: ASTM A167, Type 304,

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts. Stainless Steel reinforcement where installed on Stainless Steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm). Utilize Stainless Steel with stainless steel duct applications.

2.2 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

B. Joint and Seam Tape: 2 inches (50 mm) wide; glass-fiber-reinforced fabric.

C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

2.3 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
   2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
   1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
   2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
   3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless steel ducts in corrosive areas shall be Stainless Steel

2.4 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction per SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
   1. Manufacturers:
      a) Ductmate Industries, Inc.
      b) Nexus Inc.

c) Ward Industries, Inc.

C. Formed-On Flanges: Construct per SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
   1. Manufacturers:
      a) Ductmate Industries, Inc.
      b) Lockformer.
   2. Duct Size: Maximum 30 inches (750 mm) wide and up to 2-inch wg (500-Pa) pressure class.
   3. Longitudinal Seams: Pittsburgh lock sealed with non-curing polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359 inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of non-braced panel area unless ducts are lined.

2.5 ROUND DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round, Longitudinal and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Duct Joints Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

D. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

E. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

F. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter

PART 3 EXECUTION

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts per the following:
   1. Supply Ducts: 2-inch wg (250 Pa).
   2. Return Ducts (Negative Pressure): 1-inch wg (250 Pa).
   3. Exhaust Ducts (Negative Pressure): 1-inch wg (250 Pa)

3.2 SERVICE

A. Ductwork systems serving and/or located in corrosive areas to be stainless steel.

3.3 DUCT INSTALLATION

A. Construct and install ducts per SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round and flat-oval ducts in lengths not less than 12 feet (3.7 m) unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches (300 mm), with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to provide necessary clearances around electrical panels

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches (38 mm).

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Retain first paragraph below for projects in seismic areas.

O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

P. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

Q. Paint interiors of metal ducts, that do not have duct liner, for 24 inches (600 mm) upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

3.4 SEAM AND JOINT SEALING

A. Seal duct seams and joints per SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg (500 Pa), seal transverse joints.

B. Seal ducts before external insulation is applied.

3.5 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches (600 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet (5 m) and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. Install concrete inserts before placing concrete.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors.

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Clean the following metal duct systems by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   4. Coils and related components.

C. Cleanliness Verification:
   1. Visually inspect metal ducts for contaminants.
   2. Where contaminants are discovered, re-clean and re-inspect ducts.

END OF SECTION

SECTION AIR DUCT ACCESSORIES
233300

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Volume dampers.
   2. Motorized control dampers (for stand-alone applications).
   3. Turning vanes.
   4. Fire Dampers
   5. Duct-mounting access doors.
   6. Flexible connectors.
   7. Flexible ducts.
   8. Pleated Air Filters
   9. Duct accessory hardware.

B. Related Sections include the following:
   1. Division 23 Section "HVAC Instrumentation and Controls" for electric damper actuators.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Motorized control dampers and damper motors.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 PRODUCTS

2.1 GENERAL

A. Provide accessories suitable for the environment being served by the duct or the area where the duct is located. Match duct material. For Stainless steel ductwork, use stainless steel duct accessories.

2.2 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.3 SHEET METAL MATERIALS

A. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 (Z180) **(Z275)** coating designation; G90 coating for Holding Building; ducts shall have mill-phosphatized finish for surfaces exposed to view.

B. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

C. Stainless Steel: ASTM A 480/A 480M.

D. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063, temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.4 VOLUME DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming & Ventilating.
   3. Vent Products Company, Inc
   4. Metalaire, Inc.
   5. Or equal.

B. Service: Utilize stainless steel version of standard volume damper described herein for use with stainless ductwork applications.

C. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
   1. Pressure Classes of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

D. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
   1. Aluminum Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
   2. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
   3. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
   4. Blade Axles: Stainless steel.
   5. Bearings: Oil-impregnated bronze.
   6. Tie Bars and Brackets: Galvanized steel.

E. Jackshaft: 1-inch- (25-mm-) diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 MOTORIZED CONTROL DAMPERS

A. Manufacturers
   1. TAMCO Series 9000 ECT (Insulated w/ thermally broken frame)
   2. Arrow Series AFDTI-25LT (Insulated w/ thermally broken frame)

B. Insulated dampers shall be as follows:
   1. Extruded aluminum damper frame shall not be less than .080" thickness. Damper frame to be 4" deep and shall be insulated with polystyrene on three sides if “Installed to Duct” type and on four sides if “Flanged to Duct” type.

2. Blades to be extruded aluminum, internally insulated with non-CFC, expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R 2.29 and a temperature index of 55.
3. Blade gaskets shall be Flexible silicon. Frame seals shall be of extruded flexible silicon. Gaskets to be secured in an integral slot within aluminum extrusions.
4. Bearings to be comprised of a clean inner bearing fixed to a 7/16" aluminum hexagon blade pin rotating within a polycarbonate outer bearing inserted in frame.
5. Linkage hardware shall be installed in frame side and be constructed of aluminum and corrosion resistant zinc and nickel plated steel, complete with cup point trunnion screws for slip proof grip.
6. Dampers to be designed for operation in temperatures ranging between 40ºF and 212ºF.
7. Damper shall be available with either opposed blade action for modulating control or parallel blade action for basic open/close control. See damper schedule for Action specified.
8. Air leakage through a 48" x 48" damper shall not exceed 4.12 cfm/sq. ft. against 4" w.g. differential static pressure @ standard air leakage data to be certified under the AMCA certified ratings program.
9. Leakage shall not exceed 6.7 cfm/sq. ft. against 4" differential static pressure @ 40ºF.
10. Pressure drop of a fully open 48" x 48" damper shall not exceed .03" w.g. at 1,000 fpm.
11. Dampers shall be made to size required without blanking off free area.
12. Dampers shall be “Flanged to Duct” configuration.
13. Installation of dampers shall be in accordance with manufacturer’s installation guidelines.

C. Damper Motors / Actuators
1. Provide damper motors/actuators of the electronic type sized to operate their respective dampers with sufficient reserve power to provide smooth modulation action.
2. Provide damper operators with spring return, which shall return all dampers to their normally open or normally closed positions upon failure of controlling signal. Dampers shall be 24V type with end switches for proof of open and/close.
3. In corrosive areas, provide damper motor enclosure suitable for use in corrosive atmosphere.
4. Manufacturers:
   a) Belimo Aircontrols, Inc.
   b) Honeywell
   c) Johnson Controls

2.6 FIRE DAMPERS

A. Manufacturers:
1. Air Balance, Inc.
2. CESCO Products.
3. Greenheck.
4. Ruskin Company.
5. Vent Products Company, Inc.
6. Or equal.

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 3 hours.

D. Frame: Curtain type with blades outside airstream fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.138-inch-thick and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Fusible Links: Replaceable, 165 deg F rated.

2.7 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- (38-mm-) wide, double-vane, curved blades of galvanized sheet steel or stainless steel as applicable, set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set into vane runners suitable for duct mounting.

C. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. METALAIRE, Inc.
4. Ward Industries, Inc.
5. Or Equal.

2.8 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.

1. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
2. Provide number of hinges and locks as follows:
   a) Less Than 12 Inches (300 mm) Square: Secure with two sash locks.
   b) Up to 18 Inches (450 mm) Square: Two hinges and two sash locks.
3. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
4. Insulation: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.
5. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

C. Manufacturers:

1. American Warming and Ventilating.
2. CESCO Products.
3. Ductmate Industries, Inc.
4. Greenheck.
5. McGill AirFlow Corporation.
6. Ventfabrics, Inc.

2.9 FLEXIBLE CONNECTORS

A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) (146 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Select metal compatible with ducts.

C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

D. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.

2.10 FLEXIBLE DUCTS

A. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor barrier film.

1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20.3 m/s).
3. Temperature Range: Minus 20 to plus 210 deg F (Minus 28 to plus 99 deg C).

B. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches (75 to 450 mm) to suit duct size.

2.11 PLEATED AIR FILTERS

A. Where air filters are not specified as part of the equipment, provide the following pleated air filters as a minimum.

1. Filter depth: 2”
2. Efficiency: MERV 8
3. Media Type: Synthetic
4. Frame Material: Beverage Board
5. Max Operating Temp: 200 deg F
6. Manufacturer: American Air Filter (AAF) MEGApleat M8 Premium High Capacity Filter.

2.12 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.1 CONTROL DAMPER APPLICATIONS

A. If damper applications are not otherwise indicated, use the following:

1. Dampers Used in Mixing Airstreams: Parallel-blade.
2. Modulating or Throttling: Opposed-blade.
3. Two-position Shutoff: Parallel blade.
4. Outside Air: Thermally broken dampers.

3.2 APPLICATION AND INSTALLATION

A. Install duct accessories per applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers for all diffuser and equipment connections unless noted otherwise.

F. Provide additional balancing dampers that are required to achieve a balanced system but not shown on the drawings. Install balancing dampers a minimum of two duct widths from branch takeoff.

G. Provide test holes at fan inlets and outlets and elsewhere as indicated.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Downstream from volume dampers, turning vanes, and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.

4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.
5. On sides of ducts where adequate clearance is available.

I. Install the following sizes for duct-mounting, rectangular access doors:
1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).

J. Label access doors per Division 23 Section "Identification for HVAC Systems."

K. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

L. For fans developing static pressures of 5-inch wg (1250 Pa) and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect flexible ducts to metal ducts with draw bands.

N. Install duct test holes where indicated and required for testing and balancing purposes.

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION

SECTION HVAC FANS
233423

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Inline fans – Direct Driven
   2. Upblast Power Roof Ventilators – Direct Driven.
   3. Tube Axial Roof Upblast Fan – Belt Driven.
   4. Sidewall Propeller fans

1.2 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify per AMCA 99.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also, include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standards: Power ventilators shall comply with UL 705.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Greenheck Fan Corporation.
   2. Loren Cook Company.

2.2 IN-LINE SUPPLY & EXHAUST FANS

A. In-line centrifugal fans shall be centrifugal direct drive as indicated on drawing schedules.

B. Fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone matched to the inlet cone for precise running tolerances. Wheel shall be statically and dynamically balanced. Fan housing and shroud shall be constructed of heavy gauge aluminum with a rigid internal support structure. The fan shroud shall have a rolled bead for added strength.

C. Motors shall be mounted out of the air stream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor from an area free of discharge contaminants.
   1. Motors shall be totally enclosed, ball bearing type, permanently lubricated and readily accessible for maintenance.
   2. Provide a factory installed disconnect switch.
   3. Motors shall comply with Section 230513.
   4. Bearings and shaft: Bearing life shall be a minimum of 200,000 hours (L50) at maximum cataloged operating speed. Pulleys shall be cast iron, keyed and securely attached to wheel and motor shafts.

D. Provide direct driven fans as indicated on plan equipment schedule.

E. Fans shall be AMCA certified for air performance and UL labeled.

F. Provide with gravity or motor operated damper as indicated on the equipment schedules.

G. Special Coatings: Provide the following coating types as indicated on fan schedule.
   1. If no coating is indicated, use thermo-setting polyester urethane (Permatector - Greenheck or Lorenized - Loren Cook) coating finish.
   2. For corrosive applications, use Hi-Pro Polyester (Greenheck) Coating or Epoxy Phenolic (Loren Cook) coating – Grey color.

H. Inline fans shall be Model BQ as manufactured by Greenheck Fan Corporation, or equivalent by Loren Cook Company.

2.3 POWER ROOF VENTILATORS – UPBLAST STYLE; DIRECT DRIVE

A. General Description:
   1. Fans shall be of the centrifugal direct driven type.
   2. Roof mounted applications
   3. Performance capabilities up to 6,400 cfm and static pressure to 3” water gauge
   4. Each fan shall bear a permanently affixed manufacturer’s engraved metal nameplate containing the model number and individual serial number.

B. Wheel
   1. Material type: Aluminum
   2. Non-overloading, backward inclined centrifugal
   3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
   4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

C. Motors:
   1. Motor enclosures: Standard – Totally enclosed fan cooled. Or, as may be noted on equipment schedule.

2. Motors are permanently lubricated, heavy-duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
3. Mounted on vibration isolator, out of the airstream.
4. For motor cooling, there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
5. Accessible for maintenance

D. Housing
1. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband and motor compartment housing. Galvanized material is not acceptable.
2. Housing shall have a rigid internal support structure.
3. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing.
4. Windband to include an integral rolled bead for strength.
5. Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting and caulking are not acceptable.
6. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb.
7. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
8. Breather tube shall be 10 square inches in size for fresh air motor cooling and designed to allow wiring to be run through it.

E. Motor Cover: Construction of aluminum

F. Vibration Isolation:
1. Double studded true isolators
2. No metal to metal contact
3. Sized to match the weight of each fan.

G. Disconnect Switches:
1. Disconnect Switches must comply with Division 16 requirements.
2. NEMA rated as required for the application and special motor type as applicable
3. Positive electric shutoff
4. Wired from fan motor to junction box installed within motor compartment.

H. Drain Trough: Allows for one-point drainage for water and other residues.

I. Roof Curbs:
1. Type as required for roof application. For flat roof, curb height to be minimum 18”.
2. Mounted onto roof with fan
3. Material: Aluminum
4. Insulation thickness: 2 inches
5. Coating type: Match coating called for on Fan.
6. Curb Seal: Rubber seal between the fan the roof curb

J. Dampers:
1. Type: Gravity or motorized as indicated on equipment schedule. If none is indicated, furnish gravity damper as a minimum.
2. Balanced for minimal resistant to flow
3. Damper Coatings:
   a) Coating to be Permatector or Lorenized for standard applications.
   b) For corrosive applications, coating shall be Hi-Pro Polyester (Greenheck) or Epoxy Phenolic (Loren Cook).
      1) Supplier’s option to provide stainless steel dampers in corrosive applications.

K. Fan Coatings: Provide one of the following coating types as indicated on fan schedule. If no coatings are indicated on schedule, then provide coating as listed below for non-corrosive applications.
1. Coatings choices for corrosive applications: Coatings to be applied to all visible surfaces and all surfaces exposed to the air stream or air space. Includes roof curb.
   a) Greenheck: Hi-Pro Polyester Coating with color choice of Industrial Grey.

b) Loren Cook: Epoxy Phenolic w/ UV top coat Coating with color choice of Light Grey.

2. Coating choices for non-corrosive applications:
   a) Exterior Exposed fans & accessories: “Kynar” (Custom Color) as specified below shall be used on all fans, accessories, roof curbs, that may be exposed on the exterior of the structure.
      1) “Kynar” - Organic Coating * Architectural-grade, factory-applied organic coating, 70% PVDF Resin, with chrome phosphate pretreatment. Comply with AAMA 2605-98. Final color selection by Owner/Architect.
   b) Non-exterior exposed fans and accessories located within the structure out of public view shall be coated with Prematector (Greenheck) or Lorenized (Loren Cook) coating.

L. All fans shall bear the AMCA Certified Performance Rating Seal for both air and sound performance.

M. Centrifugal upblast power roof ventilators shall be Model CUE as manufactured by Greenheck Fan Corporation, or Loren Cook Company equivalent.

2.4 BELT DRIVE ROOF UPBLAST PROPELLER EXHAUST FANS – BELT DRIVEN

A. General Description:
   1. Discharge air directly away from the mounting surface
   2. Roof mounted applications
   3. Performance capabilities up to 64,300 cubic feet per minute (cfm) and static pressure to 1-inches of water gauge
   4. Fans are available in eight sizes with nominal wheel diameters ranging from 20 inches through 60 inches (20 - 60 unit sizes)
   5. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

B. Wheel:
   1. Material type: steel blades and hubs
   2. Securely attached to fan shaft
   3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
   4. The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

C. Motors:
   1. Motor enclosures: Totally enclosed fan cooled
   2. Inverter Duty – suitable for use with VFD drive
   3. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase
   4. Motor mounted in of the airstream
   5. Accessible for maintenance

D. Shafts and Bearings:
   1. Fan shaft shall be ground and polished solid steel with an anti-corrosive coating
   2. Permanently sealed bearings or pillow block ball bearings
   3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
   4. Bearings are 100 percent factory tested
   5. Fan Shaft first critical speed is at least 25 percent over maximum operating speed

E. Housing:
   1. Constructed of heavy gauge steel
   2. Rigid internal support structure
   3. Leakproof
   4. Constructed with windband

F. Drive Frame:
   1. Drive frame assemblies shall be galvanized steel or painted steel
   2. Drive frame shall have formed channels and fan panels shall have a deep formed inlet venturi

G. Windband:
   1. Constructed of heavy gauge galvanized steel with reinforced and bolted seams
   2. Removable windband to gain access to the fan through the butterfly dampers
   3. Directs exhaust air away from mounting surface

H. Disconnect Switches:
   1. NEMA rated: 3R for standard exterior location
      a) Positive electrical shut-off
      b) Wired from fan motor to junction box

I. Drive Assembly
   1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower
   2. Belts: Static free and oil resistant
   3. Pulleys: Cast type, keyed, and securely attached to wheel and motor shafts
   4. Motor pulleys are adjustable for final system balancing
   5. Readily accessible for maintenance

J. Butterfly Dampers:
   1. Material: Aluminum
   2. Damper type: Motorized
   3. Damper Lifter is motorized
   4. Provide weather protection and prevents backdraft when fan is not in operation
   5. Aluminum or steel with rubber seal
   6. Balanced for minimal resistance to flow

K. Curb Caps:
   1. Includes pre-punched mounting holes to ensure correct attachment to roof

L. Roof Curbs:
   1. Type as required for roof application. For flat roof, curb height to be minimum 18".
   2. Mounted onto roof with fan
   3. Material: Aluminum
   4. Insulation thickness: 2 inches
   5. Coating type: Match coating called for on Fan.
   6. Curb Seal: Rubber seal between the fan the roof curb

M. Fan Coatings: Provide the following coating types as indicated on fan schedule. If no coatings are indicated on schedule, then provide coating as listed below.
   1. Coating choices for non-corrosive applications:
      a) Exterior Exposed fans & accessories: "Kynar" (Custom Color) as specified below shall be used on all fans, accessories, roof curbs, that may be exposed on the exterior of the structure.
         1) "Kynar" - Organic Coating * Architectural-grade, factory-applied organic coating, 70% PVDF Resin, with chrome phosphate pretreatment. Comply with AAMA 2605-98. Final color selection by Owner/Architect.

N. Fans shall be as manufactured by Greenheck Fan Corporation, or Loran Cook Fan Company.

2.5 PROPELLER EXHAUST FANS - DIRECT DRIVE

A. Provide direct drive propeller exhaust fan of size, type, configuration and capacity as scheduled and shown on the drawings and schedules.

B. Propellers shall be constructed with fabricated materials as indicated on schedules. A standard square key and set screw or tapered bushing shall lock the propeller to the motor shaft. All propellers shall be statically and dynamically balanced.

C. Motors shall be permanently lubricated, heavy duty type, carefully matched to the fan load and furnished at the specified rpm, voltage, phase and enclosure. For fans that are specified to operate with VFD drive, provide induction duty motor rated for such use.

D. Motor drive frame assemblies and fan panels shall be painted steel. Drive from assemblies shall be welded wire or formed channels and fan panels shall have pre-punched mounting holes, formed flanges, and a deep formed inlet venturi. Drive frames and panels shall be welded construction.

E. Fans shall bear the AMCA certified ratings seals for both sound and air performance.

F. Accessories: Provide fan with accessories as follows or as listed on the equipment schedule included in the drawings:
   1. Exhaust hood
   2. Wall collar
   3. Motorized insulated damper
   4. Motor guard
   5. Special Coatings: Provide the following coating types as indicated on fan schedule.
      a) Coatings
         1) For Exterior Parts that are Visible: “Kynar” – Organic Coating* Architectural-grade, factory applied organic coating, 70% PVDF Resin, with chrome phosphate pretreatment. Comply with AAMA 2605-98. Color selected by Owner
         2) For Interior and Non-Exposed to Exterior: Standard Permatector Coating.

G. Fans shall be as manufactured by Greenheck Fan Corporation, or Loran Cook Fan Company.

2.6 INDUSTRIAL CEILING FANS

A. Manufacturer: Envirofan, Model & accessories as scheduled on drawings.

B. UL Listed

C. Solid state controls

D. Motor: Direct drive with permanent split capacitor type with permanently sealed ball bearings. All motors to have built in, self-resetting internal thermal overload protector T19700.

E. Fans to be provided with factory installed secondary support cable assembly connected to motor shaft with minimum 6 feet galvanized cable1/8” 7x7 with rated breaking strength of 1700 lbs and must comply with CSA standard C22.2 September 1986.

F. Fan Blades to be straight with contoured shaped design for maximum efficiency.

G. Fans used with motor speed controls must be labeled in accordance with U.L. 507 “Suitable for use with solid state motor speed controls”

H. Factory supply accessories as noted on schedule:

I. Solid State motor speed controls (UL listed)

J. Special length down rods. Length required per schedule.

2.7 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings per AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans per AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests per AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fans & power ventilators level and plumb.

B. Support units using elastomeric mounts (25 mm).

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

D. Install units with clearances for service and maintenance.

E. Label units per requirements specified in Division 23 "Identification for HVAC Systems."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Coordinate electrical requirements. Final electrical connections shall conform to Division 26 requirements. Properly ground equipment.

1. Make final electrical interlock connections between fan operation power and automatic dampers and electrical accessories provided as part of fan package.
2. Include any necessary relays, transformers, wiring, conduit, boxes, etc as needed to make the required electrical connections. Electrical work shall conform to Division 26 requirements.
3. Dampers shall be wired to open when fan engages and to close when fan is shut down.

D. Ground equipment per Division 26

E. Connect wiring per Division 26.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

END OF SECTION

SECTION AIR INLETS & OUTLETS
233713

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Ceiling and wall mounted diffusers, registers, and grilles.
   2. Slot diffusers.
   3. Louvers.

B. Related Sections:
   1. Division 23 Section "Air Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

A. Product Data: For each product indicated, including the following:

   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

PART 2 PRODUCTS

2.1 GENERAL

A. Grilles, registers, and diffusers shall be as manufactured by one of the following:
   1. Titus
   2. Price
   3. Nailor Industries Inc.

B. Types, sizes, patterns, deflections, finishes, and all accessories are scheduled on the drawings.

C. Final Color shall be coordinated with Architect.

D. All grilles, registers and diffusers shall be compatible with adjacent wall and ceiling systems. Confirm ceiling type with architectural plans and provide appropriate frame.

E. Provide 3 operating keys for each type of volume damper.

F. Provide galvanized sheet metal transitions, collars, or plenums for attaching grilles to ductwork.

G. All grilles, registers, and diffusers located in suspended lay-in ceilings shall be with compatible with the ceiling grid system as specified the architectural documents.

2.2 DRUM DIFFUSERS

A. Design basis manufacturer: Titus Model DL.

B. Supply grilles for the sizes and mounting type, configuration and accessories as shown on the plans and schedule.

C. Outer borders shall be 1¼ inches wide and shall be constructed of heavy gauge extruded aluminum. Corners shall be assembled with full penetration resistance welds with a reinforcing steel patch for extra strength.

D. Screw holes shall be countersunk.

E. Drum shall be constructed of heavy gauge extruded aluminum and shall rotate a minimum of 25° up and down from center line of the diffuser.

F. Heavy extruded aluminum blades shall be individually adjustable.

G. Opposed-blade volume damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the grille.

H. The grille finish color shall be coordinated with the Architect. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

I. The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.3 ALUMINUM SIDEWALL SUPPLY, RETURN, EXHAUST & TRANSFER GRILLES

A. Roll formed aluminum for sizes up to 24” x 24”; extruded aluminum for larger sizes. ¾” blade spacing, double deflection, reinforced corners. Front blades parallel to the Long dimension.

B. 1-1/4" frame with countersunk screw mounting. Border type as applicable for each installation situation.

C. Finish: Coordinate color with Architect

D. Accessories as noted on schedule

E. Design basis manufacturer: Titus 300-FL – Supply; Titus 350-FS- Return.

2.4 SLOT DIFFUSERS

A. Design Basis Manufacture: Modulinear diffusers shall be TITUS model ML (supply) with slot spacing of the sizes and mounting types shown on the plans and outlet schedule. Linear slot diffusers shall be available in standard one piece lengths up to 6 feet and 1 to 8 discharge slots.

B. Diffuser lengths greater than 6 feet shall be furnished in multiple sections and will be joined together end-to-end with alignment pins to form a continuous slot appearance.

C. All alignment components to be provided by the manufacturer. The return models shall be constructed the same as supply diffusers without the pattern controllers.

D. The frame and support bars shall be constructed of heavy gauge extruded aluminum. The pattern controller shall be an aerodynamically curved “ice-tong” shaped steel deflector capable of 180° pattern adjustment from the face of the diffuser and shall allow dampering if required. Maximum pattern controller length shall be 3 feet, for diffusers longer than 3 feet pattern controllers shall be furnished in multiple sections.

E. The face finish color shall be coordinated with the architect and #84 black on the pattern controllers. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test.

F. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

G. Heavy gauge extruded aluminum end borders, end caps and mitered corners shall be available to close off the ends of the diffusers. Plenums shall be manufactured by the same manufacturer of the linear slot diffusers. Optional diffuser curving to a 6-foot minimum radius with fixed deflection shall be available as required.

H. The manufacturer shall provide published performance data for the linear slot diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.5 SUPPLY DIFFUSERS

A. Design Basis Manufacturer: Ceiling diffusers shall be TITUS Model TDC-AA (aluminum with miscellaneous steel components) for fixed, horizontal discharge pattern. These diffusers shall consist of an outer frame assembly of the sizes and mounting types shown on the plans and outlet schedule. A square or rectangular inlet shall be an integral part of the frame assembly and a transition piece shall be available to facilitate attachment of round duct. An inner core assembly consisting of fixed deflection louvers shall be available in one-, two-, three- or four-way horizontal discharge patterns. The inner core assembly must be removable in the field without tools for easy installation, cleaning or damper adjustment.

B. The finish color shall be coordinated with the Architect. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H.

C. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

D. Optional damper shall be constructed of heavy gauge steel (aluminum also available). Damper must be operable from the face of the diffuser by removing the spring loaded inner core assembly. Optional Throw Reducing Vanes (TRV) must be available to deflect a horizontal discharge airstream from each side of the TDC diffuser into diverging airstreams.

E. The manufacturer shall provide published performance data for the diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.6 LOUVERS

A. Louvers shall be as manufactured by one of the following:
   1. Greenheck ESD-435 – Stationary Louver with Drainable Blades
   2. Ruskin Company.

B. Standard Louvers
   1. Provide 4-inch deep louver
   2. Drainable blades on 37 deg & 45 deg angles, heavy channel frame
   3. Beginning point of water penetration not less than 800 FPM
   4. Recessed Mullion
   5. Birdscreen with ¾ inch screen.
   6. Fabricate of 0.081" thick extruded 6063-T5 aluminum alloy, welded assembly.
   7. Finish: 2-coat Kynar - 70% PVDF Resin, with chrome phosphate pretreatment. Comply with AAMA 2605-98. Final color selection by Architect.
   8. Provide louvers with Extended Sill
   9. Provide louvers of sizes as indicated on plans.
   10. Provide louver accessories as listed on the Louver Schedules.

PART 3 EXECUTION

3.1 GENERAL

A. Install items in accordance with manufacturer's instructions.

3.2 GRILLES, REGISTERS AND DIFFUSERS

A. Install ceiling grilles, diffusers and registers where shown on drawings.

B. Coordinate exact location of ceiling grilles, diffusers and registers with new electrical lighting and architectural reflected ceiling plans.

C. Confirm proper orientation of all units with unit manufacturer.

D. Paint ductwork visible behind air outlets and inlets matte black.

3.3 LOUVERS

A. Install louvers where shown on the plans.

B. Coordinate exact size and location of louver with new architectural drawings.

C. Confirm proper orientation and opening requirements of all units with unit manufacturer.

END OF SECTION

SECTION CONDENSING BOILERS
235216

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

B. Pre-insulated Buffer Tank

1.2 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

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

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

D. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Condensing Boilers:
      a) Leakage and Materials: 10 years from date of Substantial Completion.
      b) Heat Exchanger Damaged by Thermal Stress and Corrosion: Non-prorated for 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on drawings and equipment schedules by the following or pre-approved equal:
   1. Lochinvar Corporation

2.2 CONDENSING BOILERS

A. Description: Factory-fabricated, -assembled, and -tested, condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Stainless steel or cast aluminum, corrosion-resistant.

C. Pressure Vessel: Carbon steel with welded heads and tube connections.

D. Combustion Chamber: Stainless steel, sealed.

E. Burner: Natural gas, forced draft.

F. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and postpurge the combustion chamber.
   1. Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      a) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

H. Ignition: 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:
   1. Jacket: Sheet metal, with snap-in or interlocking closures.
   2. Control Compartment Enclosures: NEMA 250, Type 1A.
   3. Insulation: Minimum 1-inch- (50-mm-) thick insulation surrounding the heat exchanger.
   4. Combustion-Air Connections: Inlet and vent duct collars.
   5. Mounting base to secure boiler.

J. Characteristics and Capacities:
   1. Refer to equipment schedule for additional information
   2. Heating Medium: Hot water.

2.3 TRIM

A. Include devices sized to comply with ANSI B31.9, "Building Services Piping”

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic

F. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.

2.4 CONTROLS

A. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control boiler pump and burner firing rate.
   a) Controller shall turn pump for lead boiler ON when outside air temperature is 65 deg F (adjustable) or lower.
   b) Controller shall modulate burner firing rate to maintain hot water supply reset temperature control between 90 – 120 deg F (adjustable) based on outdoor temperature sensing.
   c) Controller shall provide automatic runtime and lead/lag sequencing to equalize run time of each boiler.
      1) If lead boiler fails, enable lag boiler as lead boiler.
6. Outdoor air temperature sensor and Return and Supply water temperature sensor suitable for mounting in main piping thermowells. Wiring and connections to be done in the field.

B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

C. Building Automation System Interface: Factory install hardware to enable building automation system to monitor alarms.

1. Hardwired Points:
   a) Monitoring: Common trouble alarm.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

2.6 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and acid neutralization tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect and Owner 14 days in advance of testing.

2.8 BUFFER TANK

A. Sized and configured to provide thermal storage volume and hydraulic separation of the boiler and building distribution to reduce short cycling and provide for higher operational efficiencies and extend equipment life.
   1. Tank size as indicated on drawings.

B. Materials:
   1. Glass lined steel tank.
   2. High density foam insulation with exterior enameled steel jacket
   3. Drain valve.
   4. Air Vent Connections
   5. Bulb well
   6. Boiler supply and return piping connections.
   7. Heating system supply and return connections.
   8. 3-year Tank warranty.

C. Manufacturer: Lochinvar Corporation

PART 3 EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Equipment Mounting: Install boilers on cast-in-place concrete equipment base(s).
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct bases to withstand, without damage to equipment, seismic force required by code.
   3. Construct concrete bases 4 inches (150 mm) high or to match existing base height and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of boiler unless otherwise indicated or unless required for seismic anchor support.
   4. Minimum Compressive Strength: 3000 psi at 28 days.
   5. 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.
   6. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   7. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   8. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install gas-fired boilers per NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted. This includes the mounting and wiring of remote air and water sensors. All wiring to be installed in conduit per Division 26 requirements.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 23 "Hydronic Piping."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Boiler Venting:
   1. Install flue venting kit and combustion-air intake.
   2. Connect full size to boiler connections.

I. Ground equipment per Division 26 "Grounding and Bonding for Electrical Systems."

J. Connect wiring per Division 26 "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 installation and startup checks according to manufacturer's written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
      b) Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose, without additional cost.

E. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.

2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
   a) Test for full capacity.
   b) Test for boiler efficiency at low fire, 20, 40, 60, 80, 100 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 23 54 16
FORCED AIR FURNACES AND EVAPORATOR COILS

PART 1 GENERAL

1.1 SUMMARY

A. Forced air furnaces.

B. Refrigerant cooling coil.

C. Controls - Thermostat

1.2 RELATED SECTIONS

A. Section 23 63 13 – Air Cooled Condensing Units

1.3 REFERENCES

A. Air Conditioning and Refrigeration Institute (ARI):
   1. ARI 210/240 -Unitary Air Conditioning and Air-Source Heat Pump Equipment
   2. ARI 520 -Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units
   3. ARI 630 -Selection, Installation and Servicing of Humidifiers

B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
   1. ASHRAE 14 -Methods of Testing for Rating Positive Displacement Condensing Units

C. National Fire Protection Association (NFPA):
   1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

D. American National Standards Institute (ANSI):
   1. ANSI Z223.1- National Fuel Gas Code
   2. ANSI/ASHRAE 90A - Energy Conservation in New Building Design
   3. ANSI/ASHRAE 103 - Heating Seasonal Efficiency of Central Furnaces and Boilers, Methods of Testing
   4. ANSI/NEMA MG1 - Motors and Generators
   5. ANSI/NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems
   6. ANSI/NFPA 211 - Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances

1.4 SUBMITTALS

A. Submit shop drawings in accordance with the General Conditions and Division 01.

1.5 MINIMUM WARRANTY REQUIREMENTS

A. Furnace Heat Exchanger: 20-year Heat Exchanger Limited Warranty and 5-year Limited Warranty on entire unit.

B. Cased Cooling Coil: Standard limited 5-year warranty on parts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide units with capacities as scheduled on drawings.

B. Acceptable Manufacturers:
   1. Carrier.
   2. Lennox.
   3. Trane.

2.2 MANUFACTURED UNITS

A. Configuration: Upflow, type as shown on drawings with gas burner and direct expansion refrigeration. Single or two-stage as scheduled on drawings.

B. Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner or heater, controls, air filter, concentric vent kit, refrigerant cooling coil and outdoor package containing compressor, condenser coil and condenser fan.

C. Refrigerant: Puron (R-410A).

D. Construction and Ratings: In accordance with ARI 210/240. Testing: ASHRAE 14.

E. Performance Ratings: Energy Efficiency Rating (EER) not less than requirements of ANSI/ASHRAE 90A; seasonal efficiency to ANSI/ASHRAE 103. Provide units with meet or exceed the requirement of those scheduled on the drawings.

F. Heating Capacity & Staging: As scheduled on plans.

G. Air Handling: As scheduled on plans.

H. Cooling Capacity and Staging: As scheduled on plans.

2.3 FABRICATION

A. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner.

B. Heat Exchanger:
   1. Primary: 3-Pass 20-gauge corrosion resistant aluminized steel of fold and crimp sectional design which operates under negative pressure
   2. Secondary: flow-through design having an interior laminate coating of polypropylene for corrosion resistance with fold and crip design which operates under negative pressure
   3. Power vent fan, single or 2 speed as applicable.

C. Supply Fan: Centrifugal type rubber mounted with direct drive.

D. Motor: ANSI/NEMA MG 1; 1750 rpm rubber isolated hinge mounted, 4 speed.

E. Air Filters: As called for in Section 23 33 00 - Air Duct Accessories.

2.4 BURNER

A. Gas Burner: Sealed combustion type with power vent fan, slow-opening dual rate gas valve, electric switch gas shut-off; flame proving sensor, hot surface igniter, pressure switch assembly; flame rollout switch, drain tubing and condensate trap, blower and inducer assembly, 40va transformer for thermostat power. Suitable for use with Natural gas.

B. Burner Operating Controls
   1. High Limit Control: Fixed stop at maximum permissible setting, de energizes burner on excessive bonnet temperature and re-energizes when temperature drops to lower safe value.
   2. Control Supply Fan: Bonnet temperatures and independent of burner controls, manual switch for continuous fan operation.
   3. Single or two stage control as Scheduled

C. Evaporator Coil
   1. Coil and Coil Casing: Copper tube aluminum fin assembly, galvanized drain pan, drain connection, refrigerant piping connections and factory installed thermostatic expansion valve, fully insulated cabinet.

2.5 OPERATING CONTROLS – THERMOSTAT

A. Electronic Programmable Room Heating/Cooling Thermostats with BACnet Interface:

B. Field-installed programmable, manual staged auto-changeover electronic digital thermostat. The thermostat shall offer three heating and two cooling stages with temperature control. An OFF-HEAT Auto-Cool Emerg system switch, OFF-AUTO fan switch and indicating LED's shall be provided along with 7-day programming.

C. The thermostat must also be programmable for Occupied/Unoccupied status. During Occupied, the supply fan shall remain on and the unit to cycle heating cooling as required to maintain space setpoint. During Unoccupied cycle, the supply fan is to cycle on with heating/cooling operation to maintain setback temperature.

D. Thermostat is also to provide auxiliary contact to engage auxiliary fans (where applicable) whenever the thermostat is in Occupied mode. During unoccupied mode, the auxiliary fan signal should be off.

E. Provide Honeywell TB600 Programmable thermostat or equivalent.

PART 3 EXECUTION

3.1 GENERAL

A. Coordinate furnace, cased cooling coil with air cooled condensing unit furnished under spec section 23 63 13 – Air Cooled Condensing Units. All equipment shall be matched to work together.

B. Verify pressure of natural gas to furnace. Install stepdown regulator if required.

3.2 EXAMINATION

A. Verify that floors are ready for installation of units and openings are as indicated on shop drawings. Verify that supports for air cooled condensers are completed.

B. Verify that proper power supply is available for furnace and condenser package.

C. Verify that proper fuel supply is available for connection.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install refrigerant lines from indoor equipment to outdoor condensing units. Insulate as required and recommended by manufacturer. Refrigerant lines are to be insulated.

C. Install interconnecting control wiring between thermostat, furnace and air cooled condensing unit.

D. Install to NFPA 90A and ANSI/NFPA 90B.

E. Install gas fired furnaces to ANSI Z223.1 (NFPA 54).

F. Provide vent connections to ANSI/NFPA 211.

END OF SECTION

SECTION 235523
GAS-FIRED, RADIANT HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Direct fired infrared radiant heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting & attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly of gas-fired, radiant heaters, as well as procedures and diagrams.
   4. Include diagrams for power & control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which equipment will be attached.
   2. Gas piping to heater installations
   3. Thermostats and wiring to heaters.
   4. Heater locations and clearance requirements.
   5. Other suspended ceiling components:
      a) Lighting fixtures.
      b) Air outlets and inlets.
      c) Sprinklers.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired, radiant heaters to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of radiant heaters that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: All warranty periods listed below are from date of Substantial Completion.
      a) Heater Components: Minimum of Three year(s).

PART 2 PRODUCTS

2.1 GAS FIRED RADIANT TUBE HEATER – TWO STAGE FIRING

A. Manufacturers:
   1. Design based on: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following or pre-approved equal:
      a) Vision VPLUS system as manufactured by AmbiRad.

B. Description:
   1. Direct gas fired radiant tube heater, capable of operating at two firing levels; high and low fire.
   2. Heater must can adjust both the fuel and air flow rate between the two firing rates. This maximizes the thermal and radiant efficiencies. Adjustment of the gas rate alone is not acceptable.
   3. Heaters to have a turndown ratio of at least 30%.
   4. Shall comply with the system as detailed on the schedule drawings to provide the performance required.
   5. Burners factory pre-tested and certified comply with ANSI Z83.20-2004 by the CSA
   6. Burners designed to operate on either natural gas or propane as dictated by the available fuel on site

C. Construction
   1. Burners:
      a) The burner shall be located within the combustion chamber and shall be of a low turbulence/staged combustion design. This burner design maximizing the flame length, while minimizing the noise and NOx emissions.
      b) Provide the burners as indicated on the scheme design to ensure the system capacity is achieved with due regard to the burner rating and system heat distribution
      c) The burner operating capacity shall be as stated on the scheme design drawing.
   2. Burner Controls:
      a) Factory pre-wired. Burners shall operate on 120v, 60Hz single phase supply via a three-pin plug-in power connector.
      b) Fail – Safe Features: The design of the burner shall prevent the passage of gas should any of the following conditions occur
      c) Power failure – gas valve in burner fails safe
      d) Main gas valve fails in open position
      e) Vacuum fan motor fails – the pressure switch prevents power to the burners
      f) Burners shall have a full sequence gas controller, providing direct spark ignition at the face of the burner head. There shall be a 15 second flame response time per ignition phase prior to lock-out condition. The controller shall have the facility of a minimum of three ignition phases. When the flame sense probe recognizes the burner flame is established, the spark ignition will close
      g) Gas valve shall comply with ANSI Z21.21; Standard for Automatic Valves for Gas Appliances
      h) Indicator lights: Burner power – on & flame on lights
   3. Reflectors:
      a) Stainless steel material shall direct all radiant heat output downward below the horizontal plane of the tubes, having a unique design profile to maximize the reflected radiant heat, minimize convection loss and maximize rigidity
      b) The reflectors shall be installed on all radiant pipe as detailed on the scheme drawing.
      c) Reflector end caps shall be installed at the end of reflected sections to minimize convective loss
      d) Perimeter systems must incorporate an ‘all in one’ perimeter reflector. Separate Reflector side extensions are not acceptable.
   4. Ducted Air:
      a) If there is a requirement to duct the air for combustion to the burners, the ductwork to each burner and end vent must be A. G. A. approved.
   5. Radiant Tube:
      a) Combustion chamber shall be 4” O.D. 16 ga. Alumatherm (Titanium stabilized aluminized steel)
      b) The radiant tube shall be 4” O.D. 16 ga. Alumatherm (Titanium stabilized aluminized steel)
   6. Tubing Connections:

a) Stainless steel wrap-around tube couplers, secured by torque set pins (friction secured taper wedges are not acceptable).

7. System Controls
   a) Smartcom Controller
      1) Remote Black Bulb Radiant Sensor
      2) Password Pin Protected
      3) Overtime & Holiday Settings
      4) Hours run metering and service data logging
      5) 7 Day timer per zone
      6) 2 on/off periods per day
      7) Dual temperature settings
      8) Measuring range: 23.6 – 94.6°F
      9) Optional outside sensor (Summer Lockout)
      10) Optional 4-20mA modulating output.
      11) Operation is by Class A software and type 1A action. Version U1
      12) The main supply to the electronic circuit is protected by a time delay fuse.
      13) Flame failure input: 24Vac nominal, 20Vac to 28Vac actual. Presence of voltage indicates flame failure.
      14) Remote volt-free switch outputs will be 24Vdc/5Ma
8. Remote Black Bulb Radiant Sensor
   a) The black bulb room temperature sensor is specifically designed to measure the temperature of radiant heating systems. The sensor housing is wall mounted and made from black Flame Retardant Polycarbonate.
      1) Measuring Range: 50-140°F

D. Capacities and Characteristics: As indicated on the equipment schedules.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine structures, substrates, areas and conditions, with Installer present, for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Examine roughing-in for fuel-gas piping to verify actual locations of piping connections before equipment installation.

3.2 INSTALLATION

A. Equipment Mounting: Install gas-fired, infrared heaters with continuous-thread hanger rods and hangers of size required to support weight of heaters.
   1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems per NFPA 54 & CSA B149.1.

C. Suspended Units: Mount to substrate using rigid mounting kits or brackets, supplied by manufacturer or manufactured.
   1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

D. Maintain manufacturers' recommended clearances for combustibles.

3.3 CONNECTIONS

A. Gas Piping: Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
   1. Gas Connections: Connect gas piping to radiant heaters per NFPA 54 and the fuel gas code.

B. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.

C. Electrical Connections: Comply with applicable requirements per Division 26.
   1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.4 ADJUSTING

A. Adjust initial-temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   2. Verify bearing lubrication.
   3. Verify proper motor rotation.
   4. Test Reports: Prepare a written report to record the following:
      a) Test procedures used.
      b) Test results that comply with requirements.
      c) Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 236313
AIR COOLED CONDENSING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes design, performance, refrigerants, controls, and installation requirements for air cooled compressor-condensing units associated with the Fuel Fired Furnace.

1.2 REFERENCES

A. Comply with the applicable Standards and/or Codes of ETL, cETL, NEC, ASHRAE Standard 90.1, and OSHA as adopted by the State.

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with the specifications.

B. Submittals shall include the following:

1. Dimensioned plan and elevation view drawings, required clearances, and location of all field connections.
2. Summary of all auxiliary utility requirements such as: electricity, water, gas, etc.
3. Summary shall indicate quality and quantity of each required utility.
4. Single line schematic drawing of the power field hookup requirements, indicating all items, which are furnished.
5. Diagram showing Refrigerant piping between condensing unit and DX coils in air handling unit. Show all required line sizes, traps, risers, double risers if needed.
6. Schematic diagram of control system indicating points for field interface and/or connection.
7. Diagram shall fully delineate field and factory wiring.
8. Installation manuals.

1.4 QUALITY ASSURANCE

A. Qualifications: Equipment manufacturer must specialize in the manufacture of the products specified and have ten years experience with the equipment and refrigerant offered.

B. Regulatory Requirements: Comply with the codes and standards specified.

1.5 DELIVERY AND HANDLING

A. Condensing unit shall be delivered to the jobsite with a factory holding charge and be factory charged with oil by the manufacturer.

B. Comply with the manufacturers instructions for rigging and handling equipment.

1.6 WARRANTY

A. The refrigeration equipment manufacturer's warranty shall be for a period of one year from date of equipment start up but not more than 14 months from shipment. The warranty shall cover material and workmanship that prove defective within the above period, excluding refrigerant.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide condensing units of same manufacturer as the air handling/furnace equipment for which it is connected:

1. Carrier
2. Lennox.
3. Trane.

2.2 UNIT DESCRIPTION

A. Provide and install as shown on the plans factory assembled, air cooled compressor condensing units in the quantity specified. Each unit shall consist of a hermetic compressor(s), air cooled condenser section, control system, suction and liquid connection valves, and all components necessary for safe and controlled unit operation when connected to the specified low side equipment.

2.3 DESIGN REQUIREMENTS

A. General: Provide a complete compressor-condensing unit as specified herein and as shown on the drawings. The unit shall be in accordance with the standards referenced in section 1.02 and any local codes in effect.

B. Performance: Refer to the schedule of performance on the drawings. The unit shall be capable of stable operation to a minimum of 35°F outdoor temperature. Provide Low Ambient accessory option.

C. Refrigerant: Puron (R410-A)

2.4 CONDENSING UNIT FEATURES

A. Compressors: The compressors shall be scroll type with a forced feed lubrication system and oil charge. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two pole, with inherent thermal protection on all phases and shall be mounted on RIS vibration isolators. All Models shall be furnished with a crankcase heater.

B. Condenser: The condenser coil(s) shall consist of seamless copper tubes mechanically bonded into plate type fins. The fins shall have full drawn collars to completely cover the tubes. A subcooling section shall be an integral part of the main condenser coil. Condenser fan(s) shall be propeller type arranged for vertical air discharge and individually driven by direct drive fan motor(s). The fan discharge area shall be equipped with a heavy gauge fan guard. Fan motor(s) shall be weather protected, single phase, direct drive, 1100 rpm, open drip proof type. The condenser coil(s) shall be mechanically protected from physical damage by a wire guard covering the full face area of the coil.

C. Refrigerant Circuit: The condensing unit shall be furnished with a liquid line filter drier and service valves for liquid and suction connections. The finished field installed refrigerant circuit furnished by the contractor shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line (insulated hot gas bypass line) and insulated suction line.

D. Control System: A centrally located weatherproof control panel shall contain the field power connection points, control terminal block and control system. Power and starting components shall include fan motor contactors, time delay relay(s) for the compressor(s), inherent fan motor overload protection and unit power terminal blocks for connection to remote disconnect switch. Safety and operating controls shall include a manually reset high pressure switch and an automatic reset low pressure switch. Barrier panels shall be furnished to protect against accidental contact with line voltage when accessing the control system.

E. Service Accessibility: Entrance to the separate compressor(s) and control compartment shall be through an access panel.

F. Wiring Diagrams:

1. Wiring diagrams shall be in color and marked to match the color and markings of the wires and shall be both "point to point" and "ladder" diagrams.
2. Diagrams shall be laminated in plastic and permanently fixed to the control compartment door.
3. Installation and maintenance manuals shall be supplied with each unit within the control compartment.

2.5 OPTIONS AND ACCESSORIES

A. Unit shall be supplied with the following options:

1. Cycling condenser fan control for low ambient operation to 35° F (for ACCU-2).
2. Refrigerant reservoir.

3. Low ambient kit
4. Crankcase heater
5. Liquid line solenoid valve

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in strict accordance with manufacturer's requirements, shop drawings, and contract documents.

B. Set unit on concrete equipment (housekeeping) pad if located on grade. For roof mounted applications, set unit on roof rail system which is fastened and flashed into the roof. Adjust and level unit on supports.

C. Install refrigerant piping in accordance with drawings. Seal exterior wall penetrations weather tight.

D. Evacuate the system and charge with refrigerant in accordance with standard practice.

E. Coordinate electrical installation with electrical contractor.

F. Coordinate controls with control contractor.

G. Provide all appurtenances required to insure a fully operational and functional system.

3.2 STARTUP

A. Check and assure proper system charge of refrigerant and oil.

B. Provide testing, and starting of system, and instruct the Owner in its proper operation and maintenance.

END OF SECTION

SECTION 23 72 23
237223

PART 1 GENERAL

1.1 SUMMARY

A. Section includes packaged energy recovery heating units.

1.2 SCOPE

A. Provide energy recovery air handling units designed and manufactured to the specific requirements of this project.

1.3 REFERENCES

A. ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

B. ASTM E1332 Standard Classification for Determination of Outdoor-Indoor Transmission Class

C. SMACNA HVAC Duct Construction Standards—Metal and Flexible

D. ARI 1060 Rating Air-To-Air Energy Recovery Ventilation Heat Exchangers

E. AMCA 210 Laboratory Methods of Testing Fans for Rating Purposes

F. NEMA MG1 Motors and Generators

G. AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings

H. ARI 410 Forced-Circulation Air-Cooling and Air-Heating Coils

I. UL 1995 Heating and Cooling Equipment

J. ANSI Z83.8 Standard for Gas Unit Heaters and Gas-Fired Duct Furnaces

K. ASHRAE 52-76 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI/ASHRAE Approved) (for Filters)

L. ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality

1.4 QUALITY

A. Service for the unit shall be available locally either directly from the manufacturer or from the manufacturer's certified local representative.

B. The unit shall comply with the requirements of the Buy American Act and be defined as a domestic end product as per the two-part test described therein.

C. Components not manufactured at the factory shall be provided by manufacturers regularly engaged in the production of such equipment and shall conform to recognized industry standards.

D. The unit shall meet the following specified performance parameters which serve as a basis for unit selection: airflow rates, external static pressures, and water flow rates. Additionally, the unit must meet or exceed the following specified performance parameters: coil, exchanger, and filter face velocities; cabinet leakage rate; acoustical performance; internal static pressure; and brake horsepower.

E. Units shall be built and shipped in one single piece or in separate modules, as required by the project specification and/or restrictions at the job site.

F. The performance off all heating and all energy recovery devices shall be ARI certified.

G. All fans and blowers shall conform to AMCA standard 210 and bear the AMCA certified ratings seal for performance.

H. Unit construction shall otherwise comply with ASHRAE Standard 62.1.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Structural members to which equipment or suspension systems will be attached.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

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

1. Filters: One set of each type of filter specified.
2. Fan Belts: One set of belts for each belt-driven fan in energy recovery units.
3. Wheel Belts: One sets of belts for each heat wheel.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Units shall be shipped with integral lifting lugs welded to the unit frame. Before leaving the factory, units shall be wrapped, packaged, and sufficiently protected for transportation by truck and outdoor storage. Duct connection openings shall be covered with plywood.

B. Unit should immediately be inspected for any damage that may have occurred during shipping. Care should be used whenever handling the unit to avoid damaging any components, wiring, or the unit surface finish.

C. Although the unit packaging is weather resistant, if the unit is not to be immediately installed, it should be stored in a dry place protected from weather, traffic, and unauthorized personnel.

D. If the unit is to be stored for any length of time, it must be supported and cribbed along the full length of its support channel. Major support should be provided at the perimeter of the unit and at the furnace section. The unit can rest on the angle iron perimeter frame, but should not be supported where there is no framing underneath.

E. If the unit is not immediately installed and run, the blower bearings should be re-greased and wrapped with plastic. After each month of storage, the bearings should be purged with new grease to remove any accumulated moisture.

F. If the blowers are not regularly run, the blower wheels should be manually rotated every two weeks to redistribute the grease and prevent flat spots from developing on the bearings.

1.10 OPERATIONAL REQUIREMENTS

A. Before operating the unit for any purpose or for any length of time, the ductwork should be cleaned, filters installed, bearings lubricated, and blowers test run.

1.11 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. ARI Compliance:
   1. Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
   2. Capacity ratings for air coils shall comply with ARI 410, "Forced-Circulation Air- Cooling and Air-Heating Coils."

C. ASHRAE Compliance:
   1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed per recommendations of NRCA.

E. UL Compliance:
   1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Non-ducted Heat Recovery Ventilators."
   2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Packaged Energy Recovery Units: Two years.

PART 2 PRODUCTS

2.1 PACKAGED ENERGY RECOVERY UNITS

A. Approved Manufacturers
   1. The following manufacturers are approved for this project, if they meet the all the requirements of this specification:
      a) XeteX, Inc - Model XHS. – Basis of Design.
      b) Venmar, Inc

B. Packaged, roof mounted, air-to-air heat recovery ventilator/air handling unit. Unit to include aluminum flat plate exchanger, supply air and exhaust air blowers, motors with starters and relays, outside air and return air filters, face-and-bypass dampers, and adjustable frost control, direct fired natural gas burner and controls.

C. Cabinet Construction
   1. Welded Structural Steel Base Frame and Floor:
   2. Unit shall have an all-welded base frame constructed from structural steel. The frame shall include formed supports constructed from welded structural steel under blowers and other components.
   3. The base frame shall incorporate a minimum of four (4) integral lifting lugs for every separate unit section.
   4. A 16-gauge galvanized steel interior floor shall be installed on the base frame. Openings in the floor shall be covered with a protective grate. The floor shall be insulated and a 22-gauge galvanized steel sub-floor shall be installed under the insulation.

5. Floor insulation shall be 2” thick and consist of a load-bearing, rigid, closed-cell polyiso foam core laminated to a black glass reinforced mat facer. Insulation blowing agents shall be HCFC-free and qualify under the Federal Procurement Regulation for Recycled Material. Additionally, insulation shall meet the following criteria:
    a) Insulation shall have an LTTR R-Value of 12.1 (where the LTTR is based on a 15-year time-weighted average in accordance with CAN/ULC-S770).
    b) Insulation shall have a compressive strength of 20 psi under ASTM D 1621, a density of 2 pcf under ASTM D 1622, a dimensional stability of less than 2% under ASTM D 2126, a moisture vapor transmission of less than 1 Perm under ASTM E 96, and a water absorption of less than 1% by volume under ASTM C 209. Insulation shall have a service temperature of –100 °F to 250 °F.
    c) Insulation shall be compliant with the following specifications: ASTM C1289, Type II, Class 1; UL Classified; FM Class 1 Approved; and CAN/ULC-S704. Additionally, the manufacturer’s facility shall be ISO 9002 Registered.
6. All seams in the base frame shall be sealed and the frame shall be coated with a rust inhibiting paint. The perimeter of the frame shall be insulated.

D. Drain Pans:
1. Drain pans shall be provided in all heat exchanger sections where condensate might be present.
2. Drain pans shall be double sloped, have all welded seams, MPT connections, and be constructed from 304 stainless steel. Drain pans with a bitumastic coating are not acceptable because of their poor durability.
3. Flat Plate Heat Exchanger section shall have two separate, full width, double sloped drain pans, one in the supply air plenum and one in the exhaust air plenum. Each drain pan shall be 3" deep minimum with its own MPT drain. The heat exchanger shall be removable from the unit without requiring that the drain pans be removed, deconstructed, split, or damaged in any way. Exchanger sections with one drain pan or two single-sloped drain pans are not acceptable. Configurations that require the drain pans to be removed, deconstructed, split, or damaged in any way to remove the exchanger are not acceptable.
4. For indoor units, all drain connections shall terminate on the sides of the unit. For Outdoor units, drain connections shall terminate either on the sides of the unit or on the bottom of the unit.

E. Hinged Access Doors:
1. Access to all exchanger surfaces, blowers, motors, filters, and other components requiring regular maintenance shall be provided through access doors.
2. Access doors shall have double-wall construction with 18 gauge (minimum) galvanized steel inner and outer walls and 3# density hardboard fiberglass insulation. Access door construction shall be otherwise consistent with the unit panel and frame.
3. Access doors shall be held closed by a minimum of two roller cam latches. Door hinges shall be galvanized steel. Doors shall be removable from the unit frame.
4. Access door frames shall be made from galvanized steel. Continuous hollow rubber gasket shall be applied to all access openings to provide water and airtight seals.
5. Doors shall come equipped with hook-and-keeper holders to keep doors open against the side of the unit. Holders shall be zinc-plated and incorporate spring-loaded keepers to prevent unintentional door release.

F. Acoustical Performance:
1. The acoustical performance of cabinet panels shall be tested by an accredited independent laboratory under the ASTM E90 and E1332 standards and have a certified STC rating of 39 for 2” walls and an OITC rating of 27 for 2” walls.
2. Sound absorption data is not an acceptable substitute for OITC rating data. Manufacturer shall provide a testing report from the accredited independent laboratory and Transmission Loss data upon request.
3. Acoustical performance shall be as follows:

Transmission Loss: ASTM E90(04) and E413(04)

Hz:	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
2" Walls	15	15	18	18	33	36	39	42	42	46	51	54	56	57	62	66	69	70
4" Walls	12	20	28	29	39	41	43	45	46	49	53	55	58	58	61	64	66	67

4. Perforated panels shall be installed on the walls of all blower sections to provide additional acoustical insulation.

G. Double Wall Construction:
   1. Cabinet frame exterior shall be of formed 18 gauge (minimum) galvanized steel. Panels (fixed and access) to be of 18-gauge galvanized steel.
   2. Frame and panels to be double-walled construction with 2" thick insulation. Insulation shall be 3# density hardboard, composed of glass fibers bonded with a thermoset resin and faced with an adhered black non-woven mat surface, and meet the following criteria:
      a) Insulation shall have a thermal resistance R factor of 2" thick: 8.7
      b) Insulation shall comply with ASTM 612, Type 1A and 1B. Under ASTM E 84 it shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50, and under NFPA 259 its limited combustible rating shall be less than or equal to 3,500 Btu/lb.
      c) Insulation shall have received a rating of Pass under the following tests: the ASTM C 665 Corrosiveness test, the ASTM C 1338 test for Fungi Resistance, and the ASTM C 1304 test for Odor Emission.
      d) Insulation shall be UL listed and the manufacturer's plant shall be ISO 9001 registered.
      e) Urethane foam insulation is not acceptable.
   3. Frame and panels to have an internal liner of 22 gauge (minimum) and be sealed with silicone sealant to provide a complete vapor barrier and non-contaminating surface to all air streams.
   4. Framing and panels of dissimilar metals that could create a galvanic effect

H. Rooftop/Outdoor Construction Options:
   1. Weatherized outdoor construction shall include sloped roof panels with rain gutters that overhang the sidewalls to shed water away from access panels, capped roof seams, outside air shut-off damper, exhaust air backdraft damper, and intake and exhaust weather hoods with bird-screens. Secondary roof panels that could trap moisture are not allowed.
   2. Roof curb shall be 16 gauge (minimum) galvanized steel with additional supports and cross members as needed. Curb to have wood nailer and 1.5" thick fiberglass insulation of the same type used to insulate the unit floor.

I. Unit Finish:
   1. Unit exterior shall be constructed from Galvanealed Steel and primed with industrial Pro-Cryl® universal primer. Primer shall be a single component cross-linking acrylic and designed for construction applications. It shall further be VOC compliant, rust inhibitive, and early moisture and corrosion resistant.
   2. Primer shall be applied to a thickness of 5.0 – 10.0 wet mils / 2.0 – 4.0 dry mills.
   3. A top coat of Sher-Cryl® HPA high performance acrylic shall be painted over the primer. The top coat shall be an ambient cured, one component acrylic coating. It shall be chemical, flash and rust, and corrosion resistant.
   4. The top coat shall be applied to a thickness of 6.0 – 10.0 wet mils / 2.5 – 4.0 dry mills.
   5. The exterior finish shall meet the following performance requirements:

Method:	ASTM D4541	ASTM D3894, 10 Cycles, 3360 hours	ASTM D2794	ASTM D2485
Result:	500 psi	Pass	>140 in. lbs.	200 °F

Flexibility	Moisture Condensation Resistance	Pencil Hardness	Salt Fog Resistance
ASTM D522, 180° bend, 1/4" mandrel	ASTM D4585, 100° F, 1250 hours	ASTM D3363	ASTM B117, 1250 hours
Pass	Pass	H	Pass

   6. Exterior finish shall provide performance comparable to products formulated to federal specification AA50570/AA50557 and paint specification SSPC-Paint 23.
   7. Unit interior finish shall be G90 Galvanized steel.

J. Air-to-Air Flat Plate Heat Exchanger

1. Aluminum Exchanger: Air-to-air heat exchanger shall be an XLT stationary, aluminum, flat-plate type manufactured by XeteX. Heat transfer surface shall be 0.008” thick formed aluminum plates. Exchangers with plate spacers, folded ribs, or other obstructions located at regular intervals across the entire span of the plate are not acceptable.
2. Exchanger frame profiles and corners shall be all aluminum. End plates shall be galvanized steel.
3. Exchanger shall be capable of withstanding a pressure difference between airflows of up to 7.2" w.c. without deforming air passages. Unit shall be capable of operating in temperatures up to 190 oF.
4. Standard cell construction shall have a maximum cross contamination between airflows of 0.1% of total airflow.
5. The entire cell shall be capable of being visibly inspected and cleaned as required.

K. Blowers, Motors, and Mounts: The following blowers, motors, and mounts shall be provided.
1. Backward Inclined (BI) Single Width Single Inlet (SWSI), Air Foil (AF) Plenum or Plug Blower
   a) Supply and Exhaust air blowers shall be a backward inclined airfoil centrifugal plenum type without scroll housing arranged in a draw-through configuration. Fans shall incorporate a wheel; heavy gauge reinforced steel inlet plate shaft, and bearings in AMCA Arrangement 3 configuration to form a heavy-duty integral unit. Blowers shall be tested to AMCA standard 210 and bear the AMCA certified ratings seal for performance.
   b) The fan blades shall continuously welded, die-formed airfoil type, designed for maximum efficiency and quiet operation. Impellers shall be statically and dynamically balanced, non-overloading, and complete fan assembly shall be test balanced at the operating speed prior to shipment.
   c) Shafts are to be sized for first critical speed of at least 120% the maximum speed for the class.
   d) Bearings are to be heavy duty; grease lubricated, and selected for minimum average bearing L-10 life of 40,000 hours at the maximum class rpm.
   e) Fan motors shall be premium efficient, ODP, T-frame, 1750 rpm nominal with minimum service factor of 1.15 mounted on an adjustable base.
   f) Motor and blower are to be mounted on common frame and isolated from unit case with spring isolators with a minimum of 1" deflection with flexible duct connections.
   g) Motors, blowers, and frames shall be coated with rust inhibiting paint

L. Heaters: Direct Fired Gas Heater
1. Burner Unit: The burner unit shall house a direct-fired burner suitable for burning natural gas/propane/propane air mixture with a standard turn-down ratio of 30:1. The burner shall be capable of delivering 500,000 BTU per foot or burner. The gas burner shall be cast iron with ribbed, perforated stainless steel side plates and stainless steel end plates. The pilot shall be automatically ignited by the spark rod through a standard ignition transformer. Main burner and pilot gas piping connections shall be made accessible. A standard externally adjustable damper type profile plate shall be provided.
2. Gas Train: Shall consist of main inlet hand operated valve, main gas regulator, two main gas valves and operator, modulating gas valve, pilot hand shutoff, pilot regulator and pilot solenoid valve. Gas train is also available with optional Factory Mutual (FM) or Industrial Risk Insurers (IRI) compliance.
3. Controls: Standard Controls shall consist of line to 110-volt control transformer, blower motor starter and overload, discharge temperature controller, pressure differential airflow switch, high limit, flame relay with flame rod ignition transformer and primary and secondary control circuit fusing. Optional controls include: burner on/off outdoor thermostat, audible alarm, night setback with occupied/unoccupied switch, skip-a-day or 7-day time clock, room override thermostat, low limit (freezestat), standard Volumatic, Volumatic/Recirculation, Volumatic with Autocycle, Volumatic with space pressure control panel, UL labeled control panel, unit mounted discharge sensor, circuit analyzer lights, and UV flame supervision.

M. Filters
1. 2” MERV 8 (30/30) Filters
   a) Outside air filters shall be medium-efficiency ASHRAE pleated panels consisting of cotton and synthetic media, media support grid and enclosing frame with integral channel for side-access application.

b) The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2-2007. It shall also have a MERV-A of 8 when tested per Appendix J of the same standard.
c) Initial resistance to airflow shall not exceed 0.31" w.g. at an airflow of 500 fpm.
d) A welded wire grid, spot-welded on one-inch centers and treated for corrosion resistance, shall be bonded to the downstream side of the media to maintain the radial pleat and prevent media oscillation.
e) An enclosing frame of no less than 28-point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media to prevent air bypass and include integral diagonal support members on the air entering and air exiting side to maintain uniform pleat spacing in varying airflows. The top and bottom of the enclosing frame shall include integral reinforced channels for housing installation.
f) The filter shall be classified by Underwriters Laboratories as UL Class 2.
g) Filters shall be mounted within unit in galvanized holding frames upstream of exchanger and accessible through access panels or doors.

2. Aluminum Mesh Filters
a) Return air filter media shall be processed from 3003-H14 sheet aluminum no less than 0.25" in thickness. The filtering element shall be composed of no less than six layers of this media and be corrugated from 1/4" to 3/8" to provide maximum dust holding capacity.
b) The filter frame shall be made of formed aluminum channel, not less than 0.25" thickness. Corners shall be mitered and secured at one corner by heavy rivets. Holes shall be punched on one side of the frame to facilitate drainage after cleaning.
c) The filter shall retain 290 grams of dust per 2.25 square feet of face area. The maximum resistance of the filter at full capacity shall be 0.335" w.g. at an air velocity of 250 fpm.
d) The filter shall be a permanent filter constructed entirely from aluminum to give it a resistance to rust and corrosion. The filter shall not rust, pack, or flake and shall be capable of repeated cleaning without losing shape or efficiency. The filter shall be cleanable with steam, hot water, and/or a mild aluminum-safe detergent.
e) The maximum operating temperature of the filter shall be at least 240 °F.
f) Filters shall be mounted within unit in galvanized holding frames accessible through access panels.

N. Dampers: The following dampers shall be included.
1. Outside Air Shut-Off Dampers: Outside air dampers shall be mounted on the inlet of the unit and operated by a spring return, direct-coupled on-off actuator with an end switch to be interlocked with the supply air motor relay. Dampers shall have parallel blades.
2. Exhaust Air Shut-Off Dampers: Exhaust air damper shall be mounted on the outlet of the unit and operated by a spring return, direct-coupled on-off actuator with an end switch to be interlocked with the return air motor relay. Dampers shall have parallel blades.
3. Two Position Spring Return Actuators
a) Two position spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to the damper jackshaft.
b) The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation.
c) Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation.
d) Actuators shall have reversing switch and manual override on the cover, and be protected from overload at all angles of rotation.
e) If required, 1 or 2 SPDT auxiliary switches shall be provided having the capability of being adjustable. Actuators with auxiliary switches must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings.
f) Run time shall be constant and independent of torque.
g) Actuators shall be UL listed and CSA certified, have a 5-year warranty, and be manufactured under ISO 9001 International Quality Control Standards.

O. Electrical
1. Electrical controls shall include for direct drive units: motors with internal thermal protection and relays fused branch circuit breakers, control transformer for low voltage controls, service switch, and terminal points/blocks all contained in a NEMA 3R, unit-mounted control panel.

2. A single main disconnect switch for single point power connection shall be provided. The disconnect switch shall be mounted through the access panel so that power will have to be shut-off before the access door can be opened.
3. The motor power and branch circuits shall be protected by circuit breakers so replaceable fuses will not be necessary.
4. All provided wiring and controls shall be factory tested before shipment.
5. The unit wiring diagram shall be provided in the panel.

P. Controls: The following controls shall be provided and installed by XeteX.
   1. Control Board
      a) A native BACnet, MS/TP compliant, pre-programmed, and adjustable DDC Control Board with both Ethernet and RS–485 communication ports shall be provided with the unit.
      b) The controller shall be provided with a pre-installed custom program developed for the specific requirements of each individual unit and application. The controller shall be capable of monitoring the status of all sensors; communicating with a BACnet Building Management System (BMS provided by others) or, via a gateway, other local control networks (network and gateway provided by others); and controlling all components in the unit to provide supply air at the specified conditions.
   2. Energy Recovery Control
      a) Units with Flat Plate Heat Exchangers shall be provided with a Face-and-Bypass Damper and Modulating Actuator.
      b) Full Season Operational Control: The full season operational control system shall use remote temperature sensors mounted in the entering and leaving sides of both airstreams to monitor exchanger performance. Setpoints shall be adjustable at the provided HMI or by the building management system. The DDC controller shall modulate the above-described actuator to:
         1) Prevent frost build-up. The controller shall monitor the temperature in the exhaust airstream leaving the exchanger and open the bypass side of the Face-and-Bypass damper enough to prevent the temperature from dropping below an adjustable, pre-programmed setpoint.
         2) Control heat recovery for economizer mode. The controller shall monitor the temperature of the supply air leaving the exchanger and open the bypass side of the Face-and-Bypass damper enough to prevent the temperature from rising above an adjustable, pre-programmed setpoint.
   3. Damper Control
      a) Outside Air and Exhaust Air Shut-Off dampers shall be operated by a [two position—optional modulating spring return direct-coupled actuators with end switch to be interlocked with the supply and exhaust air motor relay or relays, respectively. Actuators to be controlled by the DDC control board.
      b) Face and Bypass dampers shall be provided with a [modulating—optional two position] spring return actuator controlled by the DDC control board.
      c) Recirculation dampers shall be provided with a [modulating or two position] spring return actuator controlled by the DDC control board.
   4. Blower Control
      a) Blowers shall be provided with Variable Speed Motors for direct drive units. Variable Frequency Drives or motor Starters with overloads controlled by the DDC control board.
      b) Circuit breaker, fast acting VFD isolation fuses, output contactor, and bypass contactor shall also be provided.
      c) VFD Certifications and Ratings: All standard and optional features shall be included in a single NEMA 1, plenum rated enclosure with a UL certification label. VFDs must operate, without fault or failure, when voltage varies plus 10% or minus 15% from rating, and frequency varies plus or minus 5% from rating. VFDs shall be rated for continuous cooperation from 14 °F to 104 °F with full current without being compromised by temperature.

d) VFD Features: VFD shall include a front mounted, sealed keypad operator, illuminated LCD display that will provide complete programming, program copying, operating, monitoring, and diagnostic capability. VFD shall have embedded Building Automation System (BAS) protocols for the following network communication systems: Johnson Metasys N2, Siemens Systems 600 APOGEE, and Modbus/Memobus. A serial communication gateway for BACnet shall also be provided via an isolated MS-TP RS-485 circuit board. These protocols shall be accessible via a RS-422/485 communication port. VFD shall have a quick disconnect, removable control I/O terminal block to simplify control wiring procedures. The VFD must meet the requirements for Radio Frequency Interference (RFI) above 7 MHz as specified by FCC regulations, part 15, subpart J, Class A devices.

e) VFD Control Features: VFD shall employ microprocessor-based inverter logic, isolated from all power circuits. VFD shall include PI control logic, to provide closed loop setpoint control capability, from a feedback signal, elimination the need for closed loop output signals from a building automation system. The PI controller shall have a differential feedback capability for closed loop control of fans and pumps for pressure, flow, or temperature regulation in response to dual feedback signals. VFD shall include two independent analog inputs. One shall be 0-10 VDC. The other shall be programmable for either 0-10 VDC or 4-20 mA. Either input shall respond to a programmable bias and gain.

f) VFD Safety Features: VFD shall include loss of input signal protection, with a selectable response strategy including speed default to a percent of the most recent speed. VFD shall include electronic thermal overload protection for both the drive and motor. The electronic thermal motor overload shall be approved by UL. If the electronic thermal motor overload is not approved by UL, a separate UL approved thermal overload relay shall be provided in the VFD enclosure.

Q. Roof Curb & Support Rails

1. Provide insulated Roof Curb and support rails as recommended by unit manufacturer. Height of curb and rails as indicated on equipment schedule shown on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Receiving

1. Examine the entire unit to see that no damage has occurred during shipment. If any damage is found, report it on the bill of lading and immediately notify the trucking company.
2. Check the listed approximate weight of the unit before removing it from the truck. It should correspond with the unit ordered.
3. Using the spreader bar and integral lifting lugs, remove the unit from the truck. Only ever lift the units in an upright position by the factory-installed lifting lugs.
4. Remove any shipping hardware from the fans, vibration isolators, and any other moving parts.
5. Remove the hold down straps and any supporting devices used in shipping. Readjust and secure the vibration isolators for proper operation.
6. Make sure that all pads, curbs, or other mounting bases are level and properly dimensioned. Use shims if necessary.

B. Roof-Top Installation

1. Roof Curb: Install on roof structure or concrete base, level and secure, per The NRCA "Roofing and Waterproofing Manual - Volume 4: Construction Details - Low-Slope Roofing," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts."
2. Install air-to-air energy recovery equipment on curb and coordinate roof penetrations and flashing with roof construction. Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing.
3. Major support should be provided at the perimeter of the unit and at the furnace section. (do not support the unit where there is no framing underneath.)
4. Apply sealant to the top edge of the roof curb and lift the unit onto the curb. (Factory ordered curbs are shipped knocked down. This allows for easier field assembly.)
5. Secure and fasten the unit to the curb.
6. Once in final position on the curb, make sure that the unit is level. Use shims if necessary.
7. Units may require additional job site sealing on the joints, corners, or gasket components particularly on large units that tend to shift in shipment and rigging. Appropriate all-weather caulking should be applied on the outside unit casing anywhere leakage could occur.

C. Piping Connections
1. Install drain connections of at least the same size as the drain outlet connections on the unit.
2. Plumb and trap the condensate drains (provided by the contractor) to the nearest floor drain or drain pipe. An 8” trap must be supplied close to each drain outlet to assure a standing water column at least equal to the maximum total system air pressure that could act at the drain. Each drain must be trapped separately and independently to assure that pressure from one trap does not affect the others.
3. To assure that potentially damaging water leaks do not occur, make sure that the drain pans are not punctured by piping, electrical conduit, or anything else

D. Electrical Connections
1. Check the required power and voltage.
2. Connect the fused power and control voltage to the unit (if not provided with transformer).
3. Wire remote mounted equipment and controls (remote panels, thermostats, etc.).
4. Install the main disconnect if it is not provided on the unit.

E. Sheet Metal Connections
1. The sheet metal duct work must be connected to the unit in accordance with acceptable sheet metal procedures as outlined by the Sheet Metal and Air Conditioning National Association, Inc. (SMACNA).
2. Duct sizing, material, weight, composition, and connection methods must be in accordance with the engineering plans and specifications.
3. Vapor sealed insulation should be installed in accordance with the engineering specifications.

F. Component Check-Out
1. Check blowers for proper rotation.
2. Check all motor belts for proper tension.
3. Check damper actuators and linkages for proper operation.

G. Follow the manufacturer’s instructions found in the included General Installation and Start-Up Instructions manual to complete check-out and start-up procedures.

H. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 GENERAL - CONNECTIONS

A. Install piping adjacent to unit to allow service and maintenance.

B. Connect piping to units mounted on vibration isolators with flexible connectors.

C. Comply with requirements for ductwork specified in Division 23 Section "Metal Ducts."

D. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
1. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION

SECTION PACKAGED OUTDOOR CENTRAL-STATION AIR HANDLING UNITS 237413

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Economizer outdoor- and return-air damper section.
3. Integral, space temperature controls.

1.2 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VAV: Variable-air volume.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1-2013, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2013 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. 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.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than 10years from date of Substantial Completion.
2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.6 EXTRA MATERIALS

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

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Carrier.
2. Lennox.
3. Trane.

2.2 CASING

A. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

B. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1/2 inch (25 mm).
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Condensate Drain Pans: Formed sections of stainless-steel sheet or polymer, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1-2013.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple both sides of drain pan.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.3 FANS

A. Direct-Driven Plenum-Air Fans: Double width, plenum fan; with permanently lubricated, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

C. Relief-Air Fan: Propeller, shaft mounted on permanently lubricated motor.

D. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Coil Split: Interlaced.
3. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1-2013.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

B. Refrigeration Specialties:

1. Refrigerant: R-410A
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.

2.6 AIR FILTRATION

A. Minimum arrestance per ASHRAE 52.1, and a minimum efficiency reporting value (MERV) per ASHRAE 52.2.

1. Glass Fiber: Pleated: MERV 8

2.7 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1-2013, with bird screen and hood.

2.8 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

A. DDC Controller:

1. BACnet compatible for integration into BAS.
2. Controller shall have volatile-memory backup.
3. Safety Control Operation:

    a) Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
    b) Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F (54 deg C) enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
    c) Fire Alarm Control Panel Interface: Provide control interface to coordinate with building fire alarm system
    d) Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F (4 deg C)

4. Scheduled Operation: Set through BAS
5. Supply Fan Operation:

    a) Occupied Periods: Run fan continuously.
    b) Unoccupied Periods: Cycle fan to maintain setback temperature.

6. Refrigerant Circuit Operation:

    a) Modulate compressors, to maintain discharge air setpoint. Modulate condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.

7. Economizer Outdoor-Air Damper Operation:

    a) Occupied Periods: Open to fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 70 deg F (15 deg C). Use outdoor-air temperature to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper.
    b) Unoccupied Periods: Close outdoor-air damper and open return-air damper.
    c) Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc or 4 to 20 mA, selectable

B. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface controller for scheduled operation.
2. Interface controller to provide indication of fault at the central workstation and diagnostic code storage.
3. Provide BACnet compatible interface for central HVAC control workstation for the following:

    a) Adjusting set points.
    b) Monitoring supply fan start, stop, and operation.
    c) Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
    d) Monitoring occupied and unoccupied operations.
    e) Monitoring constant and variable motor loads.
    f) Monitoring variable-frequency drive operation.
    g) Monitoring cooling load.
    h) Monitoring economizer cycles.
    i) Monitoring air-distribution static pressure and ventilation air volume.

2.10 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

B. Low-ambient kit using variable-speed condenser fans for operation down to 0 deg F (1.7 deg C) .

C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

D. Coil guards of painted, galvanized-steel wire.

E. Insulated roof curb. Curb height shall be as listed in the Equipment Schedule shown on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Roof Curb: Install on roof structure, level and secure, per NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts. “Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi (20.7-MPa), compressive strength (28-day) concrete mix inside roof curb, 4 inches (100 mm) thick. Concrete, formwork, and reinforcement are specified in Division 03.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. 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. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Remove packing from vibration isolators.
11. Verify lubrication on fan and motor bearings.
12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. Start unit according to manufacturer's written instructions.

    a) Start refrigeration system.
    b) Do not operate below recommended low-ambient temperature.
    c) Complete startup sheets and attach copy with Contractor's startup report.

15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Calibrate thermostats.
18. Adjust and inspect high-temperature limits.
19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
20. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:

    a) Coil leaving-air, dry- and wet-bulb temperatures.
    b) Coil entering-air, dry- and wet-bulb temperatures.
    c) Outdoor-air, dry-bulb temperature.
    d) Outdoor-air-coil, discharge-air, dry-bulb temperature.

21. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
22. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a) Supply-air volume.
    b) Return-air volume.
    c) Relief-air volume.

d) Outdoor-air intake volume.

23. Simulate maximum cooling demand and inspect the following:

    a) Compressor refrigerant suction and hot-gas pressures.
    b) Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

24. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a) High-temperature limit on gas-fired heat exchanger.
    b) Low-temperature safety operation.
    c) Filter high-pressure differential alarm.
    d) Economizer to minimum outdoor-air changeover.
    e) Relief-air fan operation.
    f) Smoke and firestat alarms.

25. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to four visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 81 26
238126

PART 1 GENERAL

1.1 SUMMARY

A. Section includes ductless split-system air-conditioning unit consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

1. Filters: One set for each air-handling unit.
2. Gaskets: One set for each access door.

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. Unit shall be rated in accordance to ARI standard 240HP and bear the ARI label.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate sizes and locations of equipment pad, equipment supports, and penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a) For Compressor: Five years from date of Substantial Completion.
b) For Parts: Five years from date of Substantial Completion.
c) For Labor: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
2. Carrier Corporation
3. LG Electronics USA, Inc.

2.2 INDOOR UNITS (5 TONS (18 KW) OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection. Constructed out of galvanized metal with baked enamel finish.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:
   a) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   b) Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
   c) Enclosure Type: Totally enclosed, fan cooled.
   d) NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   e) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
   f) Mount unit-mounted disconnect switches on exterior of unit.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
7. Condensate Drain Pan:
   a) Comply with ASHRAE 62.1-2004
8. Air Filtration Section:
   a) General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum Arrestance: Per ASHRAE 52.1 and MERV per ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

2.3 OUTDOOR UNITS (5 TONS (18 KW) OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel or plastic, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a) Compressor Type: Scroll.
    b) Refrigerant Charge: R-407C or R-410A unless otherwise indicated.
    c) Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to -20 deg F (7 deg C).
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Wired, Low voltage with subbase to control compressor and evaporator fan, BACnet compatible for integration into BAS.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Low Ambient Kit: Permit operation down to -20 deg F. Provide lockout control to assure unit does not operate at outdoor temperatures lower than -20 deg F.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Provide with optional part (PDRYCB300 for LG Unit), that shall allow for remote monitoring of “operating status” via dry contacts.

F. Drain Hose: For condensate.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install wall-mounted, compressor-condenser components on, reinforced structural steel base.

D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect condensate drain piping to condensate pump located in the room. Coordinate routing of condensate drain with owner and owner’s IT equipment layouts.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks per manufacturer's written instructions.

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 23 82 29
238229

PART 1 GENERAL

1.1 SUMMARY

A. Section includes flat-pipe steel radiators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Indicate location and size of each field connection.
   4. Indicate location and arrangement of piping valves and specialties.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For radiators with factory-applied color finishes.

PART 2 PRODUCTS

2.1 FLAT-PIPE STEEL RADIATORS

A. Manufacturers:
   1. Design Basis: Runtal North America, Inc.
   2. Other Acceptable Manufacturers
      a) Vulcan Radiator.
      b) Zehnder Rittling.

B. Heating Elements: Steel, welded and formed into flat water tubes, welded to steel headers at each end with minimum thickness of 0.109 inch. Continuous strips of corrugated fins are to be welded to eh inside of each panel to increase the convective output of the radiator. Fins shall start no less than 3 inches from end of radiator and shall have no less than 32 fins per foot. Include 3/4 inch NPT threaded piping and air-vent connections.
   1. Working Pressure: 85 psig
   2. Tube Height: 2-3/4 inches
   3. Number of Tubes High: Four
   4. Number of Tubes Deep: Two
   5. Heat Output: 649 btu/h minimum.
   6. Average Water Temperature: 120 deg F
   7. Temperature Drop: 20 deg F
   8. Pressure Loss: Maximum as scheduled.

C. Mounting:
   1. At floor and other areas exposed to contact by building occupants: Floor pedestal equal to Runtal KR20 with maximum spacing of 36 inches.

D. Finish: Powder finish in custom color as selected by the Architect. Provide physical color carts and samples as part of submittal. Final finish and color to be selected by Architect.

E. Accessories:
   1. Steel piping covers finished to match radiator finish.
   2. Flexible Expansion Compensation Hoses: Minimum 400 psig working pressure, and operating temperatures from 33 to 211 deg F.

3. Other accessories as indicated in equipment schedule.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive radiators for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of radiators.

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

3.2 INSTALLATION

A. Install units level and plumb.

B. Install expansion compensation hoses.

C. Install accessory covers and extension piping covers.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 23 21 13 "Hydronic Piping & Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect radiators and components to piping according to Section 23 21 13 "Hydronic Piping & Specialties."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Section 23 09 00 "Instrumentation and Control for HVAC."

D. Install piping adjacent to radiators to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 238239
ELECTRIC HEATING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Electric Unit Heaters – Corrosion Resistant Wash-down Type

B. Electric Unit Heaters - Standard

C. Electric Wall Heaters

D. Electric Baseboard Heaters

E. Electric Quartz Lamp Infrared Heaters

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For Electric Heating Units to include emergency, operation, and maintenance manuals.

1.4 REGULATORY REQUIREMENTS

A. Conform to applicable code for internal wiring of factory wired equipment.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.6 SEQUENCING AND SCHEDULING

A. Install units (equipment exposed to finished areas) after walls and ceiling are finished and painted. Avoid damage.

PART 2 PRODUCTS

2.1 ELECTRIC UNIT HEATERS – CORROSION RESISTANT

A. Electric unit heaters shall be INDEECO TRIAD SERIES, Qmark, or Markel.

B. Built-in controls, UL listed for corrosive areas and NEMA 4X hose down requirements. Heater to be forced fan type of the KW rating, voltage, and phase specified in the schedule. Also, acceptable are equivalent units from Qmark, Markel or TPI.

C. The heating elements shall be type 304 stainless steel or finned tubular construction with stainless steel fittings.

D. The motor shall be UL listed, totally enclosed with permanently lubricated ball bearings, designed to resist moisture and corrosion, fitted with an epoxy coated fan blade and factory wired to NEMA 4X enclosure.

E. Heating elements and motor to be enclosed in round, heavy 16-gauge stainless steel shroud, with stainless steel louvered outlet grille and plated rear grille.

F. Single point, line voltage connection for incoming power for 208, 240, and 480V heaters.

G. NEMA 4X enclosure to house element terminals and following standard built-in controls: Automatic reset over temperature cutout, 24V control transformer, fan delay relay, required contactors, and terminal block for field wiring. For heaters above 12 KW, a separate motor contactor will be supplied.

H. The following controls are to be built-in and factory-prewired in the NEMA 4X enclosure:
   1. Thermostat with external adjustable knob.
   2. Three position selector switch.
   3. Pilot light to indicate when heating elements are energized.

I. Units shall be epoxy coated for additional corrosion protection.

J. Provide units with stainless steel mounting bracket also epoxy coated.

2.2 ELECTRIC UNIT HEATERS – STANDARD

A. Assembly: UL listed and labeled assembly with terminal box and cover, and built-in controls.

B. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material or exposed helical coil of nickel-chrome resistance wire with refractory ceramic support bushings, as applicable.

C. Cabinet: 18 gage steel with easily removed front panel with integral air outlet and inlet grilles.

D. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard.

F. Motor: Horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

G. Mounting Bracket: Provide with Universal wall or ceiling bracket.

H. Control: Provide integral power disconnect switch and integral thermostat.

I. Provide electric unit heaters with capacities as scheduled or indicated on drawings. Acceptable manufacturers to be: Qmark type MUH unit heaters, Markel, or TPI.

2.3 ELECTRIC WALL HEATERS

A. Architectural Heavy-duty wall heater: 16-gauge steel bar grille construction with tamper resistant construction and semi-recessed mounting box.

B. Steel finned metal sheath electric heating elements.

C. Integral thermostat - tamper resistant.

D. Thermal overheat protectors, built in power disconnect switch, built in fan delay switch.

E. Permanently lubricated totally enclosed fan motor. U.L. listed.

F. Provide electric wall heaters with capacities as scheduled or indicated on drawings. Acceptable manufacturers to be: QMark type AWH 4000 Series as indicated on the equipment schedule, Markel, or equal.

2.4 ELECTIC BASEBOARD HEATERS

A. Enclosures shall be constructed of reinforced 16-gauge steel to withstand heavy-duty, commercial-institutional use. A built-in wire way runs length of heater.

B. Heating elements shall be steel tubular with aluminum fins.

C. Each electric baseboard shall be completely factory assembled, wired, tested, and shipped as a single assembly to eliminate jobsite confusion and loss of parts, and to speed installation.

D. All electric baseboards and electrical accessories shall be listed by Underwriters Laboratories, Inc.

E. Manual disconnect switch shall provide tamper resistant means of disconnecting individual convector power circuit for service or temporary shutdown.

F. Comfort control SPST thermostat with adjustment range between 55 deg F to 85 deg F and manually set "No Heat" position shall be factory installed in baseboard cabinet. "No Heat" position shall deenergize heating elements.

G. Enclosure shall be chemically treated to resist corrosion and finished in neutral white baked enamel. Finish shall be mar and temperature resistant to retain appearance throughout years of usage.

H. Provide electric baseboard heaters with capacities as scheduled or indicated on drawings. Acceptable manufacturers to be: QMark QMKC Series, Markel, or equal.

2.5 ELECTRIC QUARTZ LAMP INFRARED HEATERS

A. Housing: Provide the following:
   1. Indoor Units: Standard - 20-gage Galvanized steel with baked on brown enamel finish. ETL listed for both indoor and totally exposed outdoor applications.
   2. Outdoor Units: 20-gage Stainless Steel. ETL listed for both indoor and totally exposed outdoor applications.

B. Reflectors and End Caps: 0.040 gold anodized aluminum reflectors and end caps. Five choices of reflector patterns.
   1. 30 degree narrow (symmetric and asymmetric).
   2. 60 degree medium (symmetric and asymmetric).
   3. 90 degree wide (symmetric).

C. Elements: Clear quartz lamps. Coiled tungsten filament located within a sealed quartz envelope, halogen filled, with porcelain end caps and 6” wire pigtail leads.
   1. 96% radiant delivered efficiency with high moisture and thermal shock resistance.
   2. Instantaneous heat -up and cool-down performance.
   3. Available wattages from 500 to 3800 watts per element.
   4. Available voltages from 120 to 600 volts.

D. Controls and accessories: Provide the following.
   1. Adjustable mounting brackets – stainless steel construction.
   2. Wire Guards,
   3. Thermostats for indoor mounted units.
   4. Power Contactor panels.
   5. On-Off Switches for outdoor mounted units.

E. Manufacturers: Provide Electric quartz lamp infrared heaters with capacities as scheduled or indicated on the drawings. Acceptable manufacturers to be Fosteria, TH & THSS Series Mul-T-Mount electric Infrared heater units, TPI, or Markel equivalents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive electric heating units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install units level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment per Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring per Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION

SECTION RADIANT HYDRONIC IN-FLOOR HEATING SYSTEM
238316

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes radiant heating piping and fittings, distribution manifolds with balancing and flow control valves.

1.2 SUBMITTALS

A. Product Data: Radiant heating piping specialties, including rated capacities and water flow and pressure drops of selected models.

A. Shop Drawings: Show piping layout and details drawing to scale, including valves, manifolds, controls and support assemblies and their attachments to the building structure. Layout shall include tubing layout for zones indicated on plans along with manifold layouts and cabinets.

B. Operation and Maintenance Data: For radiant-heating piping valves and equipment to include in operation and maintenance manuals.

1.3 COORDINATION

A. Coordinate layout and installation of radiant heating piping and suspension system with building and structural components.

A. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.

B. Coordinate size and location of access panels to allow access to manifolds concealed in walls.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver and store piping and equipment in shipping containers with labeling in place. Pipe to be kept in original shipping boxes until required for installation. Do not expose pipe to ultraviolet light for more than 90 days.

A. Protect piping and manifolds from entry of contaminating materials by installing suitable plugs in all open pipe ends until installation. Where possible, connect pipes to assembled manifolds to eliminate possibility of contaminants.

B. Piping shall not be dragged across the ground or concrete surfaces, and shall be stored on a flat surface with no sharp edges.

C. Pipe shall be protected from oil, paint, grease, direct sunlight and other elements as recommended by the manufacturer.

1.5 WARRANTY

A. The radiant floor heating pipe manufacturer shall warrant the PEX piping to be free from defects in material and workmanship for a period of 25 years. Submitted warranty documents must include a completed site inspection report (SIR) in accordance with the pipe manufacturer's installation recommendations. The design shall be approved either by submittal or stamped by a registers engineer as being complete and accurate.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Rehau Inc.
2. Uponor Inc.

2.02 CARRIER PIPING

A. Material: Crosslinked polyethylene (PEX) carrier pipe shall conform to the requirements of one or more of the following: ASTM F876, ASTM F877. PEX carrier pipe shall have a minimum degree of crosslinking of 70% when tested in accordance with ASTM D2765, Method B, and shall be capable of continuous operation at 200°F.

B. Oxygen Diffusion Barrier: Coextruded barrier layer that limits oxygen diffusion through the PEX carrier pipe to less than 0.32 mg/m^2/dat 104°F temperature, as defined by DIN 4726, shall be applied to the PEX carrier pipe.

2.03 THERMAL INSULATION

A. Material: Thermal insulation shall be made from closed-cell polyurethane foam. Minimum density to be 3.5 lb/ft^3, measured in accordance with ASTM D1622. Closed cell structure to be minimum 90%, in accordance with ASTM D2856. Thermal insulation shall be bonded to carrier pipe.

B. Thermal Conductivity: Closed cell foam insulation shall have a maximum thermal conductivity of 0.02 BTU/hr-ft-°F, measured in accordance with ASTM C177.

C. Permeability: Closed cell foam insulation shall have a minimum water diffusion resistance of 90 µ, and a maximum water absorption of 1.5% after 24 hours, in accordance to DIN 53428.

2.04 OUTER CASING

A. Material: Outer casing shall be made from seamless, extruded low density polyethylene (LDPE).

B. Profile: Outer casing shall have corrugated profile. Outer casing shall be bonded to thermal insulation.

C. Markings: The outer casing shall be marked with the following information, repeated no less than every 5 feet (1.5 meters):

1. Manufacturer name or trade name
2. Carrier pipe nominal size and Standard Dimensional Ratio (SDR)
3. Temperature and pressure ratings
4. Footage markings

2.05 FITTINGS

A. General: Mechanical fittings to be of compression nut or compression-sleeve style, manufactured of metal suitable for the fluid application, in a size suitable for the PEX carrier pipe dimensions.

B. Fittings with Solder-joint Ends: Solder-joint end dimensions shall be in accordance with ASME B16.18, ASME B16.22 or MSS SP-104.

C. Tapered Threaded Ends: Fitting threads shall be right-hand, conforming to ASME B1.20.1, and shall be tapered threads (NPT).

D. Compression Nut Fittings: Mechanical compression nut fittings to consist of a barbed insert, a compression ring and a compression nut. Fittings must meet the temperature and pressure performance requirements of the PEX carrier pipe.

E. Compression-Sleeve Fittings: Mechanical compression-sleeve cold-expansion fittings to consist of a metal ribbed insert and a metal compression-sleeve. Fittings must meet the temperature and pressure performance requirements of the PEX carrier pipe.

2.2 MANIFOLDS

A. Materials: Distribution Manifolds shall be manufactured of brass or copper and be supplied by the piping manufacturer as part of a proven cataloged system.

A. Manifolds shall be equipped with visual flow gauges, balancing and isolation valves for each circuit, isolation valves, supply and return thermometers, and fill ports. Manifolds to be supplied completely assembled. Provide identification plate identifying room served and zone number.

PART 3 EXECUTION

3.1 HEAT-TRANSFER PIPING INSTALLATION

A. Install piping downstream from manifolds without joints.

B. Pre-insulated carrier pipe with outer PE jacket shall be installed underground from manifold to radiant floor zones.

A. Secure piping in concrete floors by attaching pipes to concrete reinforcement using plastic tie straps.
   1. Piping that must pass through expansion joints shall be covered in protective polyethylene convoluted sleeving (flexible conduit) extending 15 inches on each side of the joint. Sleeving must be secured on pipe to prevent movement during installation of the concrete slab. Coordinate exact location of saw joints in field.
   2. Provide pipe supports as required to maintain equal depth for entire loop.

B. Install manifolds in flush mounted wall cabinets at locations shown on the drawings.

3.2 FIELD QUALITY CONTROL

A. Test Preparation:
   1. Temporarily restrain expansion joints so they are not damaged due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   2. Flush with clean water, and clean strainers.
   3. Install relief valve set at a pressure no more than one-third higher than test pressure.

B. Tests:
   1. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig (690 kPa).
   2. After hydrostatic test pressure has been applied, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
   3. Maintain system under test pressure and monitor while concrete floor slab is being poured to ensure no piping is punctured or severed during construction of slab.
   4. Prepare a written report of testing.

END OF SECTION

SECTION 26 05 00
260500

PART 1 GENERAL

1.1 SUMMARY

A. The Electrical drawings do not attempt to show complete details of building construction which affects the electrical installation. The Contractor shall refer to the complete set of project drawings and specifications for additional details, which affect the proper installation of this work.

B. The mention of any article, operation, or method requires that the Contractor shall provide same and perform each operation, in complete accordance with the conditions stated. The Contractor shall provide all material, labor, equipment and transportation as necessary to complete the project in compliance with the Contract Documents. In general, this work includes everything essential for a complete electrical system in operating order as shown on the drawings and as specified.

C. All work shall be installed in accordance with all State and Local Inspection Authorities having jurisdiction together with the recommendations of the manufacturer whose equipment is to be supplied and installed under this Contract. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with the present practices of the trade shall not relieve the Contractor from providing such additional labor and materials.

D. Before submitting his bid, each bidder shall examine the drawings relating to his work and shall become fully informed as to the extent and character of the work required and its relation to other work in the building.

E. The Contractor, in conjunction with the Architect, shall establish exact locations of all materials and equipment to be installed. Consideration shall be given to construction features, equipment of other trades and requirements of the equipment proper.

F. All materials shall be suitably stored and protected prior to installation and all work shall be protected after installation, during construction and prior to acceptance.

G. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for delivery, erection and installation of all equipment and apparatus required to be installed by the Contractor. All such equipment shall be removed by the Contractor upon completion of the project.

1.2 PERMITS AND LICENSES

A. The Contractor shall prepare and submit all applications and working drawings, as required, to authorities having jurisdiction over the project. All licenses and permits required shall be secured and paid for by the Contractor. The Contractor shall submit a copy of all permits secured to the Owner.

B. Provide the Owner with a written certificate that all parts of the electrical system have been inspected and final approval has been obtained from the appropriate authority having jurisdiction.

C. Provide a copy of the electrical permit to the Owner representative prior to proceeding with any work.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RNC: Rigid nonmetallic conduit.

F. Provide: Furnish, install and wire complete and ready for service.

G. Exposed: Exposed to view in any room, corridor or stairway.

H. This Contractor: The Electrical Contractor, also referred to as "The Contractor".

I. The Architect: Peckham, Guyton, Albers & Viets, Inc.

J. The Engineer: IBC Engineering Services, Inc.

K. Code: National, State and Local Electrical codes including OSHA requirements.

L. The Owner: The individual who the Owner selects as his project representative.

M. Equivalent: Manufacturers or methods listed by name in the specifications, on the drawings or in an addendum are considered to be equivalent subject to Engineer review.

N. Substitution: Any manufacturer or method other than those listed by name in these specifications, on the drawings, or in an addendum.

O. Demo (Demolish): Detach item(s) from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

P. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage to surrounding surfaces, and deliver to Owner.

Q. Remove and Reinstall: Detach item(s) from existing construction, prepare for reuse, and reinstall where indicated.

R. Existing to Remain: Existing item(s) of construction that are not to be permanently removed and that are not otherwise indicated to be demolished, removed and salvaged, or removed and reinstalled.

1.4 SUBMITTALS

A. Submit to Engineer for review, the manufacturer's shop drawings and/or equipment brochures in quantities determined by the Architect for the following

1. Panelboards.
2. Enclosed Switches and Circuit Breakers.
3. Enclosed Controllers.
4. Lighting Fixtures.
5. Fire Alarm Equipment.
6. Grounding materials.
7. Lighting Control Devices.
8. Network Lighting Controls.
9. Overcurrent Protective Device Coordination Study and Fault Current Study.

B. Shop drawings shall be submitted in advance of construction and installation so as to not cause delay in other Contractor's work and to allow for Engineer’s review.

C. All data submitted for Engineer's review shall be numbered consecutively, shall be noted to correlate with the electrical drawings, and shall bear:

1. The name and location of the project.
2. The name of the Contractor.
3. The date of submittal.
4. The date of the drawings and the date of each correction and revision
5. If more than one type of lighting fixture (or other material) is on a submitted sheet, the proposed equipment shall be conspicuously checked with red pen by the Electrical Contractor.
6. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and re-submission.
7. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.

D. The Contractor shall examine, stamp and sign shop drawings and equipment brochures prior to submission. The Contractor shall verify that the materials and equipment depicted will properly fit into the construction. The Contractor shall also review all previously completed work related to the installation of the equipment depicted to insure that it has been properly installed.

E. No materials or equipment subject to prior review by the Engineer shall be fabricated or installed by the Contractor. The Engineer's review of shop drawings shall not relieve the Contractor of responsibility for deviations from the requirements of the drawings and specifications, unless prior approval for such deviations has been granted.

F. Submit additional materials at the request of the Engineer.

G. Shop drawings shall bear the Contractor's stamp indicating approval or approved as noted.

H. Any equipment fabrication prior to shop drawing review shall be at the Contractor's risk.

1.5 MAINTENANCE MANUALS

A. The Contractor shall assemble and submit to the Architect for subsequent submission to the Owner, three complete sets of a Manual of Operation and Maintenance for each of the electrical and communications systems.

B. Each manual shall consist of a loose leaf bound volume instructing the Owner's personnel in the use, operation and maintenance of the system in question. The manual shall cover all phases of operation and maintenance of the equipment. Manuals shall accurately describe the operation, construction and adjustable features of the complete system and it's component parts.

C. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:

1. Copies of all reviewed submittals bearing Contractor’s stamp indicating approval or approved as noted.
2. Manufacturer’s wiring diagrams for electrically powered equipment.
3. Records of tests performed to certify compliance with system requirements.
4. Certificates of inspection by regulatory agencies.
5. Parts lists for manufactured equipment.
6. Preventive maintenance recommendations.
7. Warranties.
8. Overcurrent Protective Device Coordination Study and Fault Current Study Reports.
9. Additional information as indicated in the technical specification sections.

1.6 QUALITY ASSURANCE

A. Substitution of Materials: Refer to Division 01, General Conditions of the Contract, and SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN.

B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.

C. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply

D. All work and material shall conform with the National Electrical Code (ANSI/NFPA 70).

E. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by the Architect/Engineer, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, shall be so labeled.

1.7 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.

C. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.

D. Coordinate all work with other contractors/subcontractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

E. Coordinate electrical service connections to components furnished by utility companies.
   1. Coordinate installation and connection of exterior underground utilities and services, including provision for electricity-metering components.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

F. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

G. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

H. Coordination Meetings: Attend coordination meetings with other trades for the purpose of coordinating the locations of all fire protection, plumbing, HVAC and electrical work for the entire project. The goal of these meetings is to avoid conflicts between trades in the field.

I. Conflicts Between Trades: Resolve all conflicts with trades at no additional cost to the Owner or Architect/Engineer.

J. Ceiling Heights: Maintain all ceiling heights indicated on the architectural drawings. Ceiling heights will not be lowered to accommodate installation of fire protection, HVAC or electrical work. Install all work so that there is at least eight (8) inches clearance above the ceiling grid, in all areas, to facilitate installation of light fixtures. If installed work does not comply with the ceiling height requirements stated above, then the contractor shall remove and re-install work to comply with the stated requirements above at no additional cost to the Owner or Architect.

K. Ceiling Grid Priority: Lighting fixture locations take priority over diffuser and sprinkler head locations.

1.8 INTENT OF DRAWINGS AND SPECIFICATIONS

A. These specifications and attendant drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material necessary for the proper execution of the work in accordance with present practices of the trade shall not relieve the Contractor from providing such additional labor and materials. No later than ten (10) days before bid opening, the Contractor shall call the attention of the Architect/Engineer in writing to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted. If in the opinion of the Contractor there are omissions or errors in the plans or specifications, the Contractor shall clarify these points in writing with the Architect/Engineer before submitting his bid. In lieu of written clarification by addendum, resolve all conflicts in favor of the greater quantity or better quality.

B. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.

C. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits the Architect/Engineer's intent (as determined by the Engineer). Refer to the General Conditions of the Contract for further clarification.

D. It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site with the Owner's representative and be responsible for their accuracy. Where appropriate the location shall be established in accordance with the manufacturer's installation drawings and details subject to the Architect's review.

E. All sizes as given are minimum except as noted.

F. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Authority Having Jurisdiction inspections and A/E's reviews, tests and approval from the commencement until the acceptance of the completed work.

G. Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply. Refer to Division 01, General Conditions of the Contract.

H. The Contractor shall refer to shop drawings and submittal drawings for all equipment requiring electrical connections to verify rough-in and connection locations.

I. Unless specifically stated to the contrary, no measurement of an electric drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the electric drawings are subject to measurements of adjacent and previously completed work. All measurements shall be performed prior to the actual installation of equipment.

1.9 DRAWINGS

A. The Electrical drawings do not attempt to show the complete details of building construction which affect the electrical installation. The Contractor shall refer to the architectural, civil, structural and mechanical drawings for additional details which affect the proper installation of this work. Bring any discrepancies to the attention of the A/E for resolution. The Contractor is cautioned that diagrams showing electrical connections and/or circuiting are diagrammatic only and must not be used for obtaining lineal runs of wire to conduit. Wiring diagrams do not necessarily show the exact physical arrangement of the equipment.

B. The Contractor shall be responsible for all existing field conditions, review existing field conditions prior to bid and shall take into account in bid proposal. No additional compensation will be allowed due to Contractor's failure to include all necessary work in the bid proposal.

1.10 MATERIAL AND EQUIPMENT

A. All material and equipment shall be new and of the quality used for the purpose in good commercial practice, and shall be standard product of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, catalog number, and capacity or rating on a nameplate, securely affixed on the equipment in a conspicuous place.

1.11 DAMAGE TO OTHER WORK

A. The Electrical Contractor will be held rigidly responsible for all damages to the work of his own or any other trade resulting from the execution of his work. It shall be the Contractor's responsibility to adequately protect his work at all times. All damages resulting from his operations shall be repaired or the damaged portions replaced by the party originally performing the work, (to the entire satisfaction of the Architect), and all cost thereof shall be borne by the Contractor responsible for the damage.

1.12 COOPERATION WITH OTHER TRADES

A. This Contractor shall completely cooperate with all other trades in the matter of planning and executing of the work. Every reasonable effort shall be made to prevent conflict and interferences as to space requirements, dimensions, locations, openings, sleeving or other matters which tend to delay or obstruct the work of any trade.

1.13 NEGLIGENCE

A. Should the Contractor fail to provide materials, templates, etc., or other necessary information causing delay or expense to another party, he shall pay the actual amount of the damages to the party who sustained the loss.

1.14 FIELD CHANGES

A. Should any change in drawings or specifications be required to comply with local regulations and/or field conditions, the Contractor shall refer same to Architect/Engineer for approval before any work which deviates from the original requirements of the drawings and specifications is started. In the event of disagreements as to the necessity of such changes, the decision of the Architect/Engineer shall be final.

1.15 CUTTING AND PATCHING

A. Provide all necessary cutting and patching, and with approval, to permit the installation of conduit or any part of the work under this branch. The Contractor shall be responsible for any cost caused by defective or ill-timed work. Patching of holes, openings, etc. resulting from the work of this branch shall be provided by this Contractor.

1.16 STANDARDS, CODES AND PERMITS

A. All work and materials are to conform in every detail to applicable rules and requirements of National, State and Local electrical codes, laws, ordinances, and regulations. Comply with all applicable OSHA regulations.

B. Conform with other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

C. All Division 26 work shall be done under the direction of a currently State Certified Master Electrician.

D. All materials shall have a U.L. label where a U.L. standard and/or test exists.

E. Prepare and submit to all authorities having jurisdiction, for their approval, all applications and working drawings required by them. Secure and pay for all permits and licenses required.

F. Abbreviations of standards organizations referenced in this and other sections are as follows:

1. ANSI American National Standards Institute
2. ASTM American Society for Testing and Materials
3. EPA Environmental Protection Agency
4. ETL Electrical Testing Laboratories, Inc.
5. IEEE Institute of Electrical and Electronics Engineers
6. IES Illuminating Engineering Society
7. ISA Instrument Society of America
8. NBS National Bureau of Standards
9. NEC National Electric Code
10. NEMA National Electrical Manufacturers Association
11. NESC National Electrical Safety Code
12. NFPA National Fire Protection Association
13. UL Underwriters Laboratories Inc.

1.17 CLEAN-UP

A. Refer to Division 01, General Requirements, Cleaning for additional requirements.

B. This Contractor shall at all times keep the premises free from excessive accumulation of waste material or rubbish resulting from his work, including tools, scaffolding and surplus materials, and he shall leave his work broom-clean or its equivalent. In case of disputes, the Architect may order the removal of such rubbish and charge the cost to the responsible contractor as determined by the Architect/Engineer. At the time of final clean-up all fixtures and equipment shall be thoroughly cleaned and left in proper condition for their intended use.

C. The Contractor shall repair all damage to new and existing equipment resulting from his work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

1.18 TESTS

A. General: The Contractor shall provide all instrumentation, labor and conduct all tests required by the Architect. All tests shall be made before any circuit or item of equipment is permanently energized. Circuits shall be phased out and loads shall be distributed as evenly as possible on all phases. All phase conductors shall be entirely free from grounds and short circuits. All instrumentation and personnel required for testing shall be provided by the Contractor and all tests shall be conducted in the presence of the Architect or his authorized representative.

B. System Tests:

1. Service and building ground tests.
2. Secondary feeders shall have an insulation resistance test utilizing a megger applying a test potential of 500 volts DC minimum.
3. Establish secondary phase to ground voltages.
4. Set transformer taps to deliver nominal rated voltage.
5. Establish proper phase relationship and motor rotation.

The following tests are required under normal load condition:

6. Record secondary phase to phase and phase to ground voltages and phase currents at all major equipment, apparatus, and on all secondary feeders. Voltage readings shall be taken at line side terminals of distribution centers and panelboards.
7. Confirm proper phase relationship and motor rotation.
8. Confirm load balance at distribution centers and panels. Rebalance load if necessary such that the minimum unbalance between phases shall not exceed 7-1/2%.
9. Reset transformer taps if necessary to deliver nominal rated voltage. Identify final tap settings on transformers nameplates.
10. Confirm operation of all electrically operated apparatus, such as circuit breakers, transfer switches, etc., by exercising same under load.
11. Record all settings and calibrations of circuit breakers, transfer switches, transformers, meters, timing devices, etc.

C. Records: All test data obtained by the Contractor or manufacturer/supplier shall be recorded and filed with the maintenance manual as part of permanent job records. Test data shall include identification of instruments employed, (field test only) condition of test (time, date, weather, etc.), parameters of test, personnel conducting test, and any pertinent information or conditions noted during the test.

1.19 DRAWINGS OF OTHER TRADES

A. The Contractor shall consult the drawings of the work for the various other trades; field layouts of the parties performing the work of the other trades; their shop drawings, and he shall be governed accordingly in laying out his work.

B. Specifically examine shop drawings of other trades to confirm voltage, current characteristics, and other wiring requirements for utilization equipment. Bring any discrepancies to the attention of the A/E.

1.20 FIELD MEASUREMENTS

A. The Contractor shall take all field measurements necessary for his work and shall assume the full responsibility for their accuracy.

B. Should any structural interferences prevent the installation of the outlets, running of conduits, etc., at points shown on drawings, the necessary minor deviations therefrom, as determined by the Architect, may be permitted. Minor changes in the position of the outlets or equipment if decided upon before any work has been done by the Contractor shall be made without additional charge.

1.21 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE

A. Before submitting a bid, the Contractor shall familiarize himself with all features of the building and site which may affect the execution of his work. No extra payment will be allowed for the failure to obtain this information. As soon as possible but no later than ten (10) days before bid opening, the Contractor shall call the attention of the Architect/Engineer in writing of any materials or apparatus the Contractor believes to be inadequate and/or any necessary items of work omitted. If the Contractor believes there are inadequacies in the specifications or drawings, where clarifications are necessary to complete the project in accordance with the Contract Documents, the Contractor shall clarify these points with the Architect/Engineer before submitting his bid. In lieu of written clarification by addendum, resolve all conflicts in favor of the greater quantity or better quality.

1.22 GUARANTEE

A. The Contractor shall unconditionally guarantee his work and all components thereof, excluding lamps, for a period of one year from the date of his final payment. He shall remedy any defects in workmanship and repair or replace any faulty equipment which shall appear within the guarantee period to the entire satisfaction of the Owner/Architect at no additional charge.

1.23 TEMPORARY ELECTRIC

A. Temporary electrical services include all electric service required up to the time of substantial completion.

B. As soon as contract is awarded, Electrical Contractor will make all arrangements for temporary service. A 120/208 volt, 100 ampere, three phase, 4 wire service shall be extended into the building as work progresses and panels provided as necessary to provide a minimum of two weatherproof sockets per 1000 sq. ft. of floor space. Sockets shall be utilized for interior lighting and small fractional HP motors only. Cost of temporary service shall be by the Electrical Contractor. In addition, install and maintain lamps as required to provide illumination of 1/4 watt per sq. ft. throughout, or as required by any codes or ordinances. Maintain and replace all defective sockets, fuses and wiring. Remove temporary installation upon completion of permanent service. All temporary wiring shall conform to all applicable codes including NEC and OSHA.

C. Install permanent service as soon as practical.

D. All contractors shall provide and maintain their own extension cords and additional lamps as required to perform their work properly.

E. Contractors requiring temporary connections to 3 phase power service and single phase feeders for other than lighting and small fractional horsepower motorized tools shall make arrangement with the Electrical Contractor. Contractors requiring lighting outside of the building shall make their own arrangements with the Electrical Contractor and pay all costs for installation, maintenance and removal. Contractors requiring electrical equipment over one horsepower, including welders, hoists, heaters and coolers shall make their own arrangements for such service beyond the main switch and shall pay all costs thereof.

F. No permanent electrical equipment or wiring shall be used for temporary connections, unless authorized by this Section, upon signed order and with approval by the Architect on behalf of the Owner. Such approvals shall not shorten guarantee period.

1.24 DEMOLITION, RENOVATION AND DISPOSITION OF EXISTING EQUIPMENT.

A. This Contractor shall note that the existing project site will remain in service during portions of the construction period. Areas of the site will be vacated as required to facilitate construction. This Contractor shall proceed with the completion of his work in such a manner as to cause the least possible interference with the Owner's operation. All work required shall be done in a manner and time acceptable to the Owner. Outages and other work rendering existing equipment inoperative shall be held to a minimum - prior arrangements for each shall be made with the Owner and shall be acceptable as to time and duration.

B. Electrical equipment in conflict with construction shall be removed and/or relocated as indicated on the drawings, as directed or required. This Contractor shall remove all electrical equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. The Owner shall have the privilege to retain ownership of any electrical equipment that has been removed, and all such equipment shall be relocated to a designated temporary location for storage until removed by the Owner. All other equipment, conduit, conductors, and miscellaneous hardware removed shall become the property of this Contractor and shall be removed from the site.

C. Any existing circuits or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction shall be reconnected in an approved manner. In addition, any existing circuit or equipment which may require relocation or rerouting, as a result of construction, shall be considered a part of the work of this branch and shall be done by this Contractor with no additional compensation.

D. Feeders, branch circuits, and other system wiring which are to remain in service, but which are presently routed through areas being demolished shall be rerouted around demolition area.

1.25 SUBSTITUTION AND APPROVAL OF MATERIAL, EQUIPMENT OR DESIGN

A. Such requests shall be accompanied by three copies of all necessary illustrations, cuts, drawings and descriptions of material proposed for substitution and shall fully describe all points in which it differs from the articles specified. The Engineer will retain two copies and one copy returned to the Contractor with acceptance, rejection or revisions indicated thereon.

B. The proposed substitution does not affect dimensions shown on Drawings or as specified.

C. The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.

D. All proposed substitutions will be subject to satisfactory performance to the specification and considered as a deduct alternate rather than as an equivalent.

E. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs, including architectural/engineering design and construction costs, involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.

F. All substitution review costs shall be reimburse to the Engineer by the contractor or their suppliers on a Time/Material bases. This cost shall be paid on approval on disproval of the substitution material, equipment or design.

1.26 WORKMANSHIP

A. The installation of all work shall be made so that its several component parts will function as a workable system complete with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The work shall be executed in conformity with the best-accepted standard practice of the trade so as to contribute to efficiency and appearance. It shall also be executed so that the installation will conform and adjust itself to the building structure, its equipment and its usage.

1.27 COMMISSIONING

A. Section 01 91 13 “General Commissioning Requirements” requires the engagement of a Commissioning Agent to document the completion of the Plumbing, HVAC, and Electrical systems for the project. Comply with the requirements of Section 01 91 13 as a Commissioning Team member for commissioning of the various building systems.

PART 2 PRODUCTS

2.1 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Stainless steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches on-center, in webs.

D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

F. Expansion Anchors: Carbon-steel wedge or sleeve type.

G. Toggle Bolts: All-steel springhead type.

H. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 CONCRETE BASES

A. Concrete: 3000-psi, 28-day compressive strength.

B. Provide a 4” housekeeping pad under any floor mounted electrical equipment as directed by the Engineer.

2.3 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Stainless steel U-channel system components.

B. Install equipment grounding conductors in all feeders and branch circuits.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
   a) Field Welding: Comply with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.5 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 07 Section “Through-Penetration Firestop Systems.”

3.6 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.8 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.9 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:
   1. Raceways.
   2. Building wire and connectors.
   3. Supporting devices for electrical components.
   4. Electrical identification.
   5. Electricity-metering components.
   6. Concrete bases.
   7. Electrical demolition.
   8. Cutting and patching for electrical construction.
   9. Touchup painting.

3.10 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 Section "Painting."
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.11 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 260503
260503 EQUIPMENT MOUNTING REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical equipment mounting height requirements applicable to all Division 26 sections.

1.2 REFERENCES

A. NECA - Standard of Installation.

B. NFPA - National Fire Protection Association.

C. ADA- American with Disabilities Act.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. The mounting heights described below are the standard mounting heights. All mounting heights indicated on the drawings shall supersede the mounting heights described herein for that item only.

B. All mounting heights are to the centerline of the item unless otherwise noted.

C. All equipment installed in this project shall be mounted per the Americans with Disabilities Act.

3.2 MOUNTING HEIGHTS

A. Wiring Devices
   1. Switches and Switch/Receptacle Combinations: 46 inches above finished floor.
   2. Receptacles
      a. Standard: 18 inches above finished floor.
      b. Above countertops: 6 inches above backsplash.

B. Telecommunications Outlets
   1. Standard: 18 inches above finished floor.
   2. Above countertops: 6 inches above backsplash
   3. Wall mount: 54 inches above finished floor.

C. Low Voltage Switching Equipment
   1. Switches: 46 inches above finished floor.
   2. Relay panels: 72 inches above finished floor to top of enclosure.

D. Disconnect Switches
   1. Disconnect Switches: 46 inches above finished floor to top of enclosure.

E. Panel Boards
   1. Panel boards: 72 inches above finished floor to top of enclosure; install panel boards taller than 72 inches with bottom of the enclosure 4 inches above floor.

F. Motor Controllers
   1. Motor controllers: 60 inches above finished floor to top of enclosure.

G. Contactors
   1. Contactors: 60 inches above finished floor to top of enclosure.

H. Time Clocks
   1. Time clocks: 60 inches above finished floor to top of enclosure.

I. Interior Luminaries

1. Fixtures to be mounted at 80" minimum above finished floor to bottom of fixture:
    a. Wall mounted luminaries protruding greater than 4 inches form wall.
    b. Pendant mounted fixtures located above walkways.
2. See electrical and architectural drawings for additional information further defining mounting height requirements.

J. Fire Alarm System

1. Pull stations: 46 inches above finished floor.
2. Alarm indicating device: 80 inches above finished floor or 6 inches below finished ceiling, whichever is lower.
3. Control panel: 72 inches above finished floor to top of enclosure.
4. Remote Annunciator: 60 inches above finished floor to top of enclosure.

K. Security Systems

1. Card Readers and key pads: 46 inches above finished floor.
2. Control Panels: 72 inches above finished floor to top of enclosure.

END OF SECTION

SECTION 26 05 13
260513

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.2 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

B. Samples: 16-inch (400-mm) lengths of each type of cable indicated.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Material Certificates: For each cable and accessory type, signed by manufacturers, certifying that cables comply with requirements specified in Part 2 Article "Source Quality Control."

F. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. 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.

E. Comply with IEEE C2 and NFPA 70.

1.4 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect and Owner at least five days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's and Owner’s written permission.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Cables:
   a) BICC Brand-Rex Company.

b) General Cable Corporation.
c) Kerite; a Marmon Wire & Cable/Berkshire Hathaway company.
d) Okonite Company (The).
e) Pirelli Cables & Systems NA.
f) Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:
a) G&W Electric Co.
b) MPHusky.
c) Raychem Corp.
d) RTE Components; Cooper Power Systems, Inc.
e) Elastimold
f) 3M Company; Electrical Products Division.

2.2 SHIELDED CABLES

A. Cable Type: MV-105.

B. Conductor: Copper.

C. Conductor Stranding: Compact round, concentric lay, Class B.

D. Strand Filling: Conductor interstices are filled with impermeable compound.

E. Conductor Insulation: Ethylene-propylene rubber complying with AEIC CS 8 NEMA WC 74 and S-97-682.

1. Voltage Rating: 5 kV.
2. Insulation Thickness: 133 percent insulation level.

F. Shielding: Copper tape, helically applied over semiconducting insulation shield.

G. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

H. Cable Jacket: Sunlight-resistant PVC.

2.3 UNSHILEDED CABLES

A. Cable Type: MV-90.

B. Conductor: Copper.

C. Conductor Stranding: Compact round, concentric lay, Class B.

D. Strand Filling: Conductor interstices are filled with impermeable compound.

E. Conductor Insulation: Ethylene-propylene rubber complying with AEIC CS 8 NEMA WC 74 and S-97-682.
1. Voltage Rating: 5 kV.
2. Insulation Thickness: 133 percent insulation level.

F. Cable Jacket: Sunlight-resistant PVC.

2.4 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.

2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink-rubber, in-line splicing kit.
4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.5 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
6. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.6 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Dead-Break Cable Terminators: Elbow-type unit with **600**-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

2.7 MEDIUM-VOLTAGE TAPES

A. Ethylene/propylene rubber-based, 30-mil (0.76-mm) splicing tape, rated for 130 deg C operation. Minimum 3/4 inch (20 mm) wide.

B. Silicone rubber-based, 12-mil (0.30-mm) self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches (38 mm) wide.

2.8 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- (250-micrometer-) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.9 FAULT INDICATORS

A. Indicators: Manual-reset fault indicator, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

2.10 SOURCE QUALITY CONTROL

A. Test and inspect cables according to NEMA WC 7 NEMA WC 8 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches (1200 to 1800 mm) on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag. Wrap ENT and ER length of cable with fire resistive tape, 1 inch wide half-lapped.

F. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

G. No Splices allowed in cable run.

H. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.

I. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal
3. Standoff Insulator: At each terminal junction, with one on each terminal.

J. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.

4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

K. Seal around cables passing through fire-rated elements according to Division 7 Section "Penetration Firestopping."

L. Install fault indicators on each phase where indicated.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

N. Identify cables according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the field quality-control testing.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following field quality-control testing:

1. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.2. Certify compliance with test parameters.

D. Remove malfunctioning units, replace with new units, and retest as specified above.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 26 05 19
260519

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Manufacturers:
   1. American Insulated Wire Corp.; a Leviton Company.
   2. General Cable Corporation.
   3. Senator Wire & Cable Company.
   4. Southwire Company.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction and ratings.

C. Conductor Material: Copper complying with NEMA WC 70/ICEA S-95-658.

D. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-THWN, and Type XHHW-2.

2.3 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. AFC Cable Systems, Inc.
   2. AMP Incorporated/Tyco International.
   3. Gardner Bender.
   4. Hubbell Power Systems, Inc.
   5. Ideal Industries, Inc.
   6. O-Z/Gedney; EGS Electrical Group LLC.
   7. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper.

B. Branch Circuits: Copper.

3.2 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

H. Underground Feeders and Branch Circuits: Type XHHW-2, single conductors in raceway. No. 10 AWG minimum size.

I. Branch circuit conductors installed inside light poles: Type XLP/RHW, single conductors.

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. Fire Alarm Circuits: Power-limited, fire-protective, signaling circuit cable.

L. Class 1 Control Circuits: Type THHN-THWN, in raceway.

M. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION

A. Do not use conductor smaller than No. 12 AWG for power and lighting circuits.

B. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated

C. All conductors and cables shall be installed in conduit, unless otherwise indicated.

D. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.

E. 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.

F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

G. All conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. Where circuit wiring length exceeds 100 feet, increase conductor size as needed to maintain a maximum voltage drop of three percent.

H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

I. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

J. Seal around cables penetrating fire-rated elements according to Division 07 Section "Penetration Firestopping."

K. Identify and color-code conductors and cables according to Division 26 Section " Identification for Electrical Systems."

L. Conductor sizes indicated on the drawings are minimum sizes. Ampacities of conductors do not take voltage drop into consideration. Contractor shall size conductors for feeders and branch circuits to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combination of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, to provide reasonable efficiency of operation.

1. As a minimum use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).

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 and UL 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.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

D. Splices are not allowed in underground feeders, and branch circuits except at junction boxes within the buildings or at light pole handholes. No splices within the in-ground handholes that are part of the underground distribution system between the buildings.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test 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

SECTION 26 05 26
260526

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical" for ground test wells.

1.2 SUBMITTALS

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

B. Product Data: For the following:

1. Ground rods.

C. Field Test Reports: Submit written test reports to include the following:

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

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

B. Comply with NFPA 70.

1.4 COORDINATION

A. Show location of all service grounding equipment and describe method of grounding installation. Show the following:

1. Service ground conductor.
2. Grounding at water meter.
3. Grounding at BUS locations.
4. Test wells.
5. Location of Ground Rods.
6. Telephone/Data grounding equipment and conductor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Grounding Conductors, Cables, Connectors, and Rods:

a) Apache Grounding/Erico Inc.
b) Copperweld Corp.

c) Erico Inc.; Electrical Products Group.
d) Ideal Industries, Inc.
e) ILSCO.
f) O-Z/Gedney Co.; a business of the EGS Electrical Group.
g) Raco, Inc.; Division of Hubbell.
h) Thomas & Betts, Electrical, a Member of the ABB Group.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Irreversible Compression Connectors: Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type (at bus bars, equipment, and test wells only).

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

1. Size: ¾ inches in diameter by 10 feet (19 by 3000 mm) in length.

B. Test Wells: Provide handholes as specified in Division 26 Section "Underground Ducts and Raceways for Electrical."

PART 3 EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections and irreversible Compression Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

F. Grounding Bus: Install in electrical and telephone equipment rooms, whole service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

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.

C. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

D. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrance to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

H. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor. Connectors must be factory filled with an oxide inhibitor. Connectors must comply with IEEE 837, UL 467 and CSA 22.2.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Precast Concrete Handholes: Install a driven ground rod adjacent to the precast handhole. Provide a No. 2 AWG copper conductor from ground rod into handhole through a waterproof PVC sleeve in handhole wall and connect to the ground bar mounted inside the handhole.

B. Connections to Precast Concrete Handhole Components: Connect exposed-metal parts, such as handhole frame and cover, cable racks, and pulling irons within the precast handhole to a ground bar located on the wall of the handhole. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train the conductors level or plumb around corners and fasten to handhole walls.

C. Ground rods not required at the precast polymer- concrete type handholes.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

    a) Equipment Rated 500 kVA and Less: 10 ohms.
    b) Equipment Rated 500 to 1000 kVA: 5 ohms.
    c) Equipment Rated More Than 1000 kVA: 3 ohms.
    d) Handhole Grounds: 10 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.7 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 32 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.3 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.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) Allied Tube & Conduit.

b) Cooper B-Line, Inc.; a division of Cooper Industries.
c) ERICO International Corporation.
d) Thomas & Betts Corporation.
e) Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. 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 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:

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:

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 055000 "Metal Fabrications" 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 required by 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 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, IMC, 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. 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.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69; or Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. 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 05 50 00 "Metal Fabrications" 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 03 30 00 "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 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior 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

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, and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 26 05 29 “Hangers and Supports for Electrical Systems” for supports, anchors, and attachment components for raceways, boxes, enclosures, and cabinets.
2. Section 26 27 26 “Wiring Devices” for devices installed in boxes.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. GRC: Galvanized rigid steel conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. PVC: Polyvinyl chloride.

F. RNC: Rigid non-metallic conduit.

1.3 ACTION SUBMITTALS

A. Product Data: For wireways and fittings, hinged-cover enclosures, and cabinets.

1.4 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.

B. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Electri-Flex Company.
4. O-Z/Gedney; a brand of EGS Electrical Group.
5. Republic Conduit.
6. Southwire Company.
7. Thomas & Betts Corporation.

8. Western Tube and Conduit Corporation.
9. Wheatland Tube Company; a division of John Maneely Company.

B. 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.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. EMT: Comply with ANSI C80.3 and UL 797.

E. FMC: Comply with UL 1; zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

a) Material: Steel.
b) Type: Compression.

2. 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.

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

2.2 NONMETALLIC CONDUITS AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. CANTEX Inc.
4. CertainTeed Corp.
5. Lamson & Sessions; Carlon Electrical Products.
6. RACO; a Hubbell company.
7. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit type and material.

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).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.
3. Square D; a brand of Schneider Electric.
4. Wiegmann; Hubbell Inc.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, unless otherwise indicated, and sized according to NFPA 70.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Cooper Technologies Company; Cooper Crouse-Hinds.
   2. EGS/Appleton Electric.
   3. Hoffman; a Pentair company.
   4. RACO; a Hubbell Company.
   5. Spring City Electrical Manufacturing Company.
   6. Thomas & Betts Corporation.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. 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.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions:
   1. Single-gang box: 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm square by 60 mm deep).
   2. Double-gang box: 4 inches square by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).
   3. Three-gang box: 4-1/2 inches by 8-5/8 inches by 2-1/2 inches deep.

J. Gangable boxes are prohibited.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Metal Enclosures, Type 4: Stainless steel.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

   1. NEMA 250, Type 1 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.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Indoors: Apply raceway products as specified below unless otherwise indicated:

   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed and Subject to Severe Physical Damage: GRC.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: GRC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in kitchens and damp or wet locations.

B. Minimum Raceway Size: **1/2-inch (16-mm) (21-mm)** trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Conduit: Use threaded rigid steel conduit fittings with bushings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use compression, steel fittings with insulated throat. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

D. Install surface raceways only where indicated on Drawings.

E. 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 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 hot-water pipes. Install horizontal raceway runs above water piping.

C. Complete raceway installation before starting conductor installation. Install temporary closures to prevent foreign matter from entering raceways.

D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. 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.

G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise noted.

H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated.

I. Install exposed conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches (300 mm)of enclosures to which attached.

K. Stub-ups to Above Recessed Ceilings:

1. Use EMT or GRC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

L. 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.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. 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 (35mm) 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.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. 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.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. 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.

U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

V. Expansion-Joint Fittings:

1. Install in each run of aboveground GRC, IMC, and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 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 deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
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.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires; use a maximum of 24 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement, and for all transformers and motors.

1. Use LFMC in damp or wet locations.
2. Install a separate ground conductor within all flexible conduit connections.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Horizontal distance shall not be less than 24 inches.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. 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.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and 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 Section 31 20 00 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
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 Section 31 20 00 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at 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 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 26 05 53 "Identification for Electrical Systems."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 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 paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 43
260543

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Ducts in direct-buried duct banks.
2. Ducts in concrete-encased duct banks.
3. Handholes and handhole accessories.

B. Related Sections include the following:

1. Division 26 Section “Common Work Results for Electrical" for supports, anchors, and identification products.
2. Division 26 Section “Grounding and Bonding for Electrical Systems" for grounding electrodes, grounding conductors, and testing of grounds.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Precast handholes.
2. Handhole cover and frame.
3. Handhole accessories.
4. Underground warning tape.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories (Including Ducts for Communications and Telephone Service): Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect at least two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

1.6 COORDINATION

A. Coordinate layout and installation of ducts and handholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to handholes.

PART 2 PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

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

1. Underground Precast Concrete Utility Structures:
   a) Crest Precast, Inc.
   b) Dalmaray Precast Concrete Products, Inc.
   c) Utility Concrete Products, LLC
   d) Wausau Concrete Co.

2. Underground Precast Polymer Concrete Utility Structures:
   a) Quazite/Hubbell Power Systems.

3. Nonmetallic Ducts and Accessories:
   a) Cantex, Inc.
   b) Certainteed Corp.; Pipe & Plastics Group.
   c) Lamson & Sessions; Carlon Electrical Products.

2.2 CONDUIT

A. Conduit and fittings are specified in Division 26 Section "Raceways and Boxes for Electrical Systems."

2.3 DUCTS

A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

B. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-80-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.4 HANDHOLES

A. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of handhole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading.

B. Polymer Concrete Handholes: Molded fiberglass reinforced precast polymer concrete, with (150-mm-)cable entrance at each end and gasketed heavy-duty bolted cover with nonskid finish and legend. Unit, when buried, shall be designed to support ANSI/SCTE 77 Tier 15 loading for driveway, parking lot, and off-roadway applications subject to occasional non-deliberate heavy vehicular traffic

C. Cover Legend: "ELECTRIC" for power circuits 600V and less, or “COMMUNICATIONS” for low voltage telephone, data, or fiber optic cables.

2.5 ACCESSORIES

A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts. (686-mm)

B. Grounding Materials: Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."(900 mm)

C. Warning Tape: Underground-line warning tape specified in Division 26 Section “Identification for Electrical Systems."

PART 3 EXECUTION

3.1 APPLICATION

A. Underground Ducts for Electrical Feeders and Branch Circuits: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-40-PVC concrete encased duct bank or Type EPC-80-PVC direct buried duct bank when crossing roads and traffic areas of parking lots.

B. Underground Ducts for Communication Circuits: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-40-PVC concrete encased duct bank or Type EPC-80-PVC direct buried duct bank when crossing roads and traffic areas of parking lots .

C. Handholes: Underground precast concrete and precast polymer-concrete utility structures.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Excavation and Fill" but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Section "Planting."

D. Restore disturbed pavement. Refer to Division 01 Section "Cutting and Patching."

3.3 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment. Slope ducts from a high point in runs between two handholes to drain in both directions.

B. Curves and Bends: Use manufactured elbows for stub-ups at equipment, at light pole bases, and at building entrances. Use long sweep bends(7.5 m) at other locations.

C. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Building Entrances: Make a transition from underground duct to conduit at least 10 feet (3 m) outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Direct-Buried, Non-encased Ducts at Non-waterproofed Wall Penetrations: Install a Schedule 40, galvanized steel pipe sleeve for each duct. Calk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.
3. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

E. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between handholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.
3. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
4. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Minimum Clearances between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
6. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in nontraffic areas and at least 30 inches (750 mm) below finished grade in vehicular traffic areas, unless otherwise indicated.

F. Direct-Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts.
2. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Excavation and Fill" for pipes less than 6 inches (150 mm) in nominal diameter.
3. Backfill: Install backfill as specified in Division 31 Section "Excavation and Fill." After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally.
4. Minimum Clearances between Ducts: 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
5. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.

G. Warning Tape: Bury warning tape approximately 6 to 8 inches below finished grade. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank.(300 mm)(600 mm)

H. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet (1.5 m) from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.

I. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

J. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

3.4 HANDHOLE INSTALLATION

A. Install handholes with top of handhole set 1 inch (25 mm) above grade.

B. Drainage: Install drains in bottom of precast handholes. Polymer concrete handholes to have open bottoms. Set handholes on a 12-inch minimum bed of gravel to allow for drainage.

3.5 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and handholes.

B. Grounding: Test grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.

D. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.6 CLEANING

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

END OF SECTION

SECTION 26 05 53
260553

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.2 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on white field.
2. Legend: Indicates voltage and service.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

D. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick (152 mm wide by 0.102 mm thick).
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend indicating type of underground line.

E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.2 NAMEPLATES

A. Engraved Plastic Nameplates: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for nameplates up to 20 sq. in. (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.

B. Fasteners for Nameplates: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.3 kg) minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: According to color-coding.

PART 3 EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Color Banding Raceways: Band exposed and accessible raceways of the systems listed below:

1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
2. Band Locations: 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.
3. Apply the following colors to the systems listed below:

    a) Fire Alarm System: Red.
    b) Telecommunication System: Blue.
    c) Security System: Yellow.

F. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

G. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

H. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried ducts and concrete encased ducts.

I. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder phase conductors:

1. 208/120-V Conductors:

    a) Phase A: Black.
    b) Phase B: Red.
    c) Phase C: Blue.

2. 480/277-V Conductors:

    a) Phase A: Brown.
    b) Phase B: Orange.
    c) Phase C: Yellow.

3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

a) Colored, pressure-sensitive plastic tape in half-lapped turns for a 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. Use 1-inch- (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
b) Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

J. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, and handholes.

1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Tag Fasteners: Nylon cable ties.
3. Band Fasteners: Integral ears.

K. Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

L. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

M. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high lettering on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use black lettering on white field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

1. Panelboards, electrical cabinets, and enclosures.
2. Access doors and panels for concealed electrical items.
3. Disconnect switches.
4. Enclosed circuit breakers.
5. Motor starters.
6. Push-button stations.
7. Contactors.
8. Dimmers.
9. Control devices.
10. Transformers.
11. Inverters.
12. Telephone switching equipment.
13. Fire alarm control panel and notification appliance circuit (NAC) panels.
14. Security system control panel.

END OF SECTION

SECTION 260573
OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD ANALYSIS STUDY

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

B. This Section includes an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2002, the IEEE Guide for Performing Arc-Flash Calculations.

1.2 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

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

1. CGI CYME.

2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
   a) Arcing faults.
   b) Simultaneous faults.
   c) Explicit negative sequence.
   d) Mutual coupling in zero sequence.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
   a) Circuit-breaker and fuse-current ratings and types.
   b) Relays and associated power and current transformer ratings and ratios.
   c) Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
   d) Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
   e) Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
   a) Special load considerations, including starting inrush currents and frequent starting and stopping.
   b) Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c) Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d) Ratings, types, and settings of utility company's overcurrent protective devices.
e) Special overcurrent protective device settings or types stipulated by utility company.
f) Time-current-characteristic curves of devices indicated to be coordinated.
g) Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
h) Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
i) Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Main service and distribution panelboards.
2. Branch circuit panelboards.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:
   a) ANSI C57.12.10.
   b) ANSI C57.12.22.
   c) ANSI C57.12.40.
   d) IEEE C57.12.00.
   e) IEEE C57.96.
2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 241 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
   a) Inrush current when first energized.
   b) Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c) Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a) Device tag.
   b) Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c) Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d) Fuse-current rating and type.
   e) Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a) Device tag.
   b) Voltage and current ratio for curves.
   c) Three-phase and single-phase damage points for each transformer.
   d) No damage, melting, and clearing curves for fuses.
   e) Cable damage curves.
   f) Transformer inrush points.
   g) Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.5 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, overcurrent protective devices within equipment.

B. Testing: Perform the following device setting and prepare reports:

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
   a) Verify that overcurrent protective devices meet parameters used in studies.
   b) Adjust devices to values listed in study results.

2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

3.6 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis.

B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system where work could be performed on energized parts.

C. Circuits 240V or less fed by single transformer rated less than 125 kVA may be omitted from the computer model and will be assumed to have a hazard risk category 0 per NFPA 70E.

D. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.

G. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

H. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:

   1. Fault contribution from induction motors should not be considered beyond 5 cycles.

I. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

J. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

K. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

L. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

M. Provide the following:

1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
2. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.
3. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

3.7 ARC FLASH LABELS

A. Provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems.
2. ANSI Z535.4 – Product Safety Signs and Labels.
3. NFPA 70 (National Electric Code) – Article 110.16.

C. The label shall include the following information:

1. System Voltage.
2. Flash protection boundary.
3. Personal Protection Equipment (PPE) category.
4. Arc Flash Incident energy value (cal/cm²).
5. Limited, restricted, and prohibited Approach Boundaries.
6. Study report number and issue date.

D. Labels shall be printed by a thermal transfer type printer, with no field markings.

E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

1. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
2. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.
3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

F. Labels shall be field installed. The technician providing the installation shall have completed an 8-Hour instructor led Electrical Safety Training Course with includes NFPA 70E material including the selection of personal protective equipment.

3.8 ARC FLASH TRAINING

A. The vendor supplying the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent. The trainer shall be an authorized OSHA Outreach instructor.

B. The vendor supplying the Arc Flash Hazard Analysis shall offer instructor led and online NFPA 70E training classes.

END OF SECTION

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PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor photoelectric switches.
3. Daylight harvesting dimming controls
4. Switch-box occupancy sensors.
5. Indoor occupancy sensors.
6. Multipole contactors.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.2 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.3 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Lighting plan showing location, orientation, and coverage area of each sensor.
2. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.3 TIME SWITCHES

A. Manufacturers:
   1. Intermatic, Inc.
   2. Paragon Electric Co.
   3. TORK.

B. Digital Time Switches: Electronic, solid-state programmable units with alphanumeric display complying with UL 917.
   1. Contact Configuration: As indicated.
   2. Contact Rating: 20-A ballast load, 120/240-V ac.
   3. Programs: Two channels, each channel is individual programmable with 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
   4. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program on selected channels.
   5. Astronomical Time: All channels.
   6. Automatic daylight savings time changeover.
   7. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.4 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers:
   1. Intermatic, Inc.
   2. Acuity Brands.
   3. Paragon Electric Co.
   4. TORK.
   5. Touchplate Technologies, Inc.
   6. Watt Stopper (The).

B. Description: Solid state, with DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; and complying with UL 773.
   1. Light-Level Monitoring Range: 1.5 to 10 fc (16 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
   2. Time Delay: 15-second minimum, to prevent false operation.
   3. Lightning Arrester: Air-gap type.
   4. Mounting: Provide with stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Manufacturers:
   1. Intermatic, Inc.
   2. Acuity Brands.
   3. Paragon Electric Co.
   4. Square D.
   5. TORK.
   6. Touchplate Technologies, Inc.
   7. Watt Stopper (The).

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate electronic dimming driver. Sensor is powered by relay unit.
3. Relay Unit: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).
5.

2.6 SWITCH-BOX OCCUPANCY SENSORS

A. Manufacturers:

1. Acuity Brands.
2. Hubbell Building Automation, Inc.
3. Hubbell Wiring Devices.
4. Watt Stopper.

B. Description: Dual-Technology type shall detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage with integral power-switching contacts rated for 800 W at 120-V ac, suitable for fluorescent light fixtures with magnetic or electronic ballasts; and rated for 1000 W at 277-V ac, suitable for fluorescent light fixtures with magnetic or electronic ballasts minimum. Unless otherwise indicated or if it is the only means of control in the area, the occupancy sensor shall function as a vacancy sensor turning luminaires off when space is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

1. Include ground wire.
2. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.

2.7 INDOOR OCCUPANCY SENSORS

A. Manufacturers:

1. Acuity Brands.
2. Hubbell Building Automation, Inc.
3. Hubbell Wiring Devices.
4. Watt Stopper.

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
   a) Sensor: Suitable for mounting in any position on a standard outlet box.
   b) Relay: Externally mounted though a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
   c) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be 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 at least 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving at least 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.

2.8 MULTIPOLE CONTACTORS

A. Manufacturers:

1. Allen-Bradley/Rockwell Automation.
2. Cutler-Hammer; Eaton Corporation.
3. GE Industrial System.
4. Square D.
5. TORK.
6. Touchplate Technologies, Inc.
7. Watt Stopper.

B. Description: Electrically operated and electrically held, 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. Control-Coil Voltage: Match control power source.

2.9 EMERGENCY LIGHTING BYPASS RELAY

A. Manufacturers:
1. LVS
2. Leviton
3. Wattstopper

B. General Description: Ceiling mounted emergency power control device that can convert and control up to 20 regular light fixtures to approved emergency lights. Device shall be UL 924 listed emergency power control device.
1. Operation: Device is equipped with an automatic diagnostic feature that is initiated when the room switch is turned off. This test procedure will turn the emergency luminaires on for at least 2 seconds, indicating that an emergency power source is available and that the luminaire is functioning correctly. At all other times the room switch operates normally by turning both regular and emergency luminaires on at the same time. During a local or general power failure, the emergency luminaire will illuminate automatically, regardless of room switch on or off position, conforming to all life safety codes.
2. Device is a manufactured control equipped with an integral manual test switch, high voltage surge protection and LED indicators that denote the presence of emergency power (red LED) and utility power (green LED).
3. Load Rating: 20A at 120V or 277V Tungsten: 1800W at 120V, 1500W at 277V, HP rating: 1HP; Ambient Temperature Rating: 32 degrees F to 140 degrees F. General use 20 Amp.
4. Mounting: Device is mounted in the ceiling in the controlled space, in a manner that readily exposes LED's and test switch to inspection, without requiring removal of ceiling tile, covers, or other obstructions.
5. Warranty: 5 years.

2.10 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 26 Section "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, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 14 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 27 Section "Structured Cabling."

PART 3 EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

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

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date from Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION

SECTION 26 09 43
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PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:
   1. Lighting load controllers.
   2. Daylight harvesting dimming controls.
   3. Indoor occupancy sensors.
   4. Wall switches.
   5. Network relay panels.

B. Related Sections include the following:
   1. Division 26 Section “Lighting Control Devices” for time switches, photoelectric switches, occupancy sensors, and multipole contactors.
   2. Division 26 Section “Wiring Devices” for wall-box dimmers and manual light switches.

1.2 DEFINITIONS

A. LED: Light-emitting diode.

B. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Shop Drawings: Detailed assemblies of standard components, custom assembled for specific application on Project.
      a) Include composite wiring and/or schematic diagram of each control circuit as proposed to be installed.
      b) Lighting plan showing location of all devices, including at minimum sensors with orientation and coverage, load controllers, and switches/dimmers.
   2. Include room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
   3. Include network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.
   4. Include example contractor startup/commissioning worksheet.

B. Field quality-control reports.

C. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Division 1 Section “Operation and Maintenance Data,” include the following:

D. Sequence of Operation, identifying operation for each room or space.
   1. Adjustments of scene preset controls.

E. Operation of adjustable zone controls.

1.5 WARRANTY

A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

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. Subject to compliance with requirements, provide products by one of the following:
   1. Wattstopper.
   2. Acuity Brands, Inc.
   3. Leviton Mfg. Company Inc.
   4. Lutron Electronics Co., Inc.

2.2 GENERAL SYSTEM REQUIREMENTS

A. Controllability:
   1. Dimming control components shall be compatible with lighting fixtures, ballasts, and transformers.

B. Description: Self-configuring, individually-addressable intelligent controls capable of digital communication between devices.
   1. Local network: Free topology, plug-in wiring system (Cat 5e or as otherwise indicated) for power and data to room devices.
   2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
   3. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
   4. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
   5. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
   6. Relay Panel and Zone Controller: Provides mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.

C. Operation: Change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
   1. Each zone shall be configurable.
   2. Memory: Retain preset scenes through power failures

2.3 LIGHTING LOAD CONTROLLERS

A. Description: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting and plug load control requirements.

B. Functions and Features:

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
4. Device Status LEDs to indicate:
   a) Data transmission
   b) Device has power
   c) Status for each load
   d) Configuration status
5. Quick installation features including:
   a) Standard junction box mounting
   b) Quick low voltage connections using standard RJ-45 patch cable
6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
   a) Turn on to 100 percent
   b) Turn off
   c) Turn on to last level
7. Each load be configurable to operate in the following sequences based on occupancy:
   a) Auto-on/Auto-off (Follow on and off)
   b) Manual-on/Auto-off (Follow off only)
8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
9. BACnet object information shall be available for the following objects:
   a) Load status
   b) Schedule state, normal or after-hours
   c) Demand Response enable and disable
   d) Room occupancy status
   e) Total room lighting and plug loads watts
10. UL 2043 plenum rated
11. Manual override and LED indication for each load
12. Zero cross circuitry for each load
13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
14. Dimming Room Controllers shall share the following features:
    a) Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
    b) Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
    c) The following dimming attributes may be changed or selected using a wireless configuration tool:
       1) Establish preset level for each load from 0-100 percent
       2) Set high and low trim for each load
       3) Initiate lamp burn in for each load of either 0, 12 or 100 hours
    d) Override button for each load provides the following functions:
       1) Press and release for on/off control
       2) Press and hold for dimming control

e) Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
f) Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
g) Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
h) All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

C. On/Off Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load
2. One or two relay configuration
3. Simple 150 mA switching power supply (Only 4 100 series devices on a Cat 5e local network)
4. Three RJ-45 local network ports with integral strain relief and dust cover

D. On/Off/0-10V Dimming Enhanced Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
2. Built in real time current monitoring
3. One, two or three relays configurations
4. Smart 250 mA switching power supply
5. Four RJ-45 local network ports. Provide integral strain relief
6. One dimming output per relay
a) 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.

E. On/Off/ Forward Phase Dimming Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) rated for 20A total load, with forward phase dimmed loads derating to 16A for some load types
2. Built in real time current monitoring
3. One or two relays configurations
4. Smart 250 mA switching power supply
5. Four RJ-45 local network ports. Provide integral strain relief
6. One dimming output per relay
a) Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads.

2.4 DAYLIGHT HARVESTING DIMMING CONTROLS

A. Description: Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities as indicated for any load type connected to the controller or panel.
1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone

B. Functions and Features:
1. Sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.

2. Sensor light level range shall be from 1-6,553 foot-candles (fc).
3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
10. Configuration LED status light on device that blinks to indicate data transmission.
11. Status LED indicates test mode, override mode and load binding.
12. Recessed switch on device to turn controlled load(s) ON and OFF.
13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
    a) Light level
    b) Day and night setpoints
    c) Off time delay
    d) On and off setpoints
    e) Up to three zone setpoints
    f) Operating mode - on/off, bi-level, tri-level or dimming
14. One RJ-45 port for connection to local network.
15. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick. Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick. Mounting brackets are compatible with J boxes and wall mounting.
16. Any load or group of loads in the room can be assigned to a daylighting zone
17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

C. Closed loop digital photosensors shall include the following additional features:
    1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
    2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
    3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.

D. Open loop digital photosensors shall include the following additional features:
    1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).

2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.

E. Dual loop digital photosensors shall include the following additional features:
1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this con
2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.
4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.
6. Device must include extendable mounting arm to properly position sensor within a skylight well.

2.5 INDOOR OCCUPANCY SENSORS

A. Description: Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation.

B. Functions and Features:
1. Digital calibration and pushbutton configuration for the following variables:
a) Sensitivity, 0-100 percent in 10 percent increments
b) Time delay, 1-30 minutes in 1 minute increments
c) Test mode, Five second time delay
d) Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
e) Walk-through mode
2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the local network.
3. Programmable control functionality including:
a) Each sensor may be programmed to control specific loads within a local network.
b) Sensor shall be capable of activating one of 16 user-definable lighting scenes.
c) Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
d) On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
1) Ultrasonic and Passive Infrared
2) Ultrasonic or Passive Infrared
3) Ultrasonic only
4) Passive Infrared only
e) Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
4. One or two RJ-45 port(s) for connection to local network.
5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
6. Device Status LEDs, which may be disabled for selected applications, including:
a) PIR detection
b) Ultrasonic detection

c) Configuration mode
d) Load binding

7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
8. Manual override of controlled loads.
9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

C. BACnet object information shall be available for the following objects:

1. Detection state
2. Occupancy sensor time delay
3. Occupancy sensor sensitivity, PIR and Ultrasonic

D. Units shall not have any dip switches or potentiometers for field settings.

E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.

F. Color: White, unless otherwise indicated by Architect.

G. Mounting: Ceiling or wall-mounted as indicated on plans.

2.6 WALL SWITCHES

A. Description: Low voltage momentary pushbutton switches in multiple button configurations.

B. Functions and Features:

1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
3. Configuration LED on each switch that blinks to indicate data transmission.
4. Load/Scene Status LED on each switch button with the following characteristics:
   a) Bi-level LED
   b) Dim locator level indicates power to switch
   c) Bright status level indicates that load or scene is active
   d) Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
5. Programmable control functionality including:
   a) Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
   b) Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

C. BACnet object information shall be available for the following objects:

1. Button state
2. Switch lock control
3. Switch lock status

D. Contains two RJ-45 ports for connection to local network.

E. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local network. No additional configuration shall be required to achieve multi-way switching.

F. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.

1. Individual button function may be configured to Toggle, On only or Off only.
2. Individual scenes may be locked to prevent unauthorized change.
3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
4. Ramp rate may be adjusted for each dimmer switch.

5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

G. Wall Plates: Use multigang plates if more than one switch is indicated at a location.

H. Color: White unless otherwise indicated by Architect; red when associated with emergency circuits.

I. Legend: Engraved or permanently silk-screened on button when available or wall plate where indicated. Use designations as coordinated with Owner, Architect, and Engineer.

2.7 NETWORK RELAY PANELS

A. Hardware: Provide lighting control panels in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. Panel interiors shall include the following features:
   a) Removable, plug-in terminal blocks with connections for all low voltage terminations.
   b) Individual terminal block, override pushbutton, and LED status light for each relay.
   c) Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
   d) Digital inputs (four RJ-45 jacks) shall support digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
   e) True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
   f) Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
   g) Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
   h) Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
   a) Electrical:
      1) 30 amp ballast at 277V
      2) 20 amp ballast at 347V
      3) 20amp tungsten at 120V
      4) 30 amp resistive at 347V
      5) 1.5 HP motor at 120V
      6) 14,000 amp short circuit current rating (SCCR) at 347V
      7) Relays shall be specifically UL 20 listed for control of plug-loads
   b) Mechanical:
      1) Replaceable, 1/2 inch KO mounting with removable Class 2 wire harness.
      2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.

3) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
4) Tested to 300,000 mechanical on/off cycles.

5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without segment networks or BAS control.
   a) Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 networked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
   b) Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
   c) Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
   d) Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
      1) Scheduled ON / OFF
      2) Manual ON / Scheduled OFF
      3) Astronomical ON / OFF (or Photocell ON / OFF)
      4) Astronomical and Schedule ON / OFF (or Photocell and Schedule ON / OFF)
   e) User interface shall be capable of programming any panel in the system
   f) Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
   g) Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.
10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.
    a) Panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
    b) Panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
    c) Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
    d) Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.

e) The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.

f) Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
   1) Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
   2) Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
   3) Binary input objects in the instance range of 1 - 64 (one per relay) for reading true on/off state of the relays.
   4) Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.

g) Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.

h) BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)

i) Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.

j) Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

B. User interface

1. Description: Each lighting control panel system shall be supplied with at least one configuration tool. As a programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer
2. Functions and Features:
   a) Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
   b) Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
   c) Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
   d) Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
   e) Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
   f) Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.

2.8 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "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 Division 26 Section "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 Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Unshielded, Twisted-Pair Data Cable: Category 5, Category 5e, Category 6, or proprietary cabling as recommended or required by manufacturer. Comply with requirements in Division 27 Section "Communications Horizontal Cabling."

PART 3 EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method:

1. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 27 Section "Communications Horizontal Cabling."
3. Minimum conduit size shall be 1/2 inch (13 mm).
4. Install system in accordance with the approved system shop drawings and manufacturer's instructions.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

G. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.

H. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.

3.2 INSTALLATION

A. Install system in accordance with the approved system shop drawings and manufacturer's instructions.

B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.
   1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
   2. Install all room to room network devices using manufacturer-supplied network wire. Network wire substitution is not permitted and may result in loss of product warranty.
   3. Low voltage wiring topology must comply with manufacturer's specifications.
   4. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

C. All line voltage connections shall be tagged to indicate circuit and switched legs.

D. Test all devices to ensure proper communication.

E. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

F. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters (e.g. blink warning, etc.)

G. Post start-up tuning - Adjust sensor time delays and sensitivities to meet the Owner's requirements 30 days from beneficial occupancy. Provide a detailed report to the Architect / Owner of post start-up activity.

H. Tighten all panel Class I conductors from both circuit breaker and to loads to torque ratings as marked on enclosure UL label.

I. All Class II cabling shall enter enclosures from within low-voltage wiring areas and shall remain within those areas. No Class I conductors shall enter a low-voltage area.

J. Run separate neutrals for any phase dimmed branch load circuit. Different types of dimming loads shall have separate neutral.

K. Verify all non-panel-based lighting loads to be free from short circuits prior to connection to room controllers.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" for identifying components and power and control wiring.
   1. All line voltage connections shall be tagged to indicate circuit and switched legs.

B. Label each dimmer module with a unique designation.

C. Label each scene control button with approved scene description as coordinated with Owner, Architect, and Engineer.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

   1. Continuity tests of circuits.
   2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

a) Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

3. Emergency Power Transfer: Test listed functions.

C. Remove and replace malfunctioning dimming control components and retest as specified above.

D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.6 DEMONSTRATION

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

END OF SECTION

SECTION 261200
MEDIUM-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:
   1. Pad-mounted, liquid-filled transformers.

1.2 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

B. Shop Drawings: Diagram power wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Underground primary and secondary conduit stub-up location.
   2. Dimensioned concrete base, outline of transformer, and required clearances.
   3. Ground rod and grounding cable locations.

B. Qualification Data: For testing agency.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Follow-up service reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Section 016000 "Product Requirements."

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 C2.

E. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.

F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store transformers so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.8 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions except for the following:
   1. Exposure to significant solar radiation.
   2. Altitudes above 3300 feet (1000 m).
   3. Exposure to fumes, vapors, or dust.
   4. Exposure to explosive environments.
   5. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
   6. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
   7. Exposure to excessively high or low temperatures.
   8. Unusual transportation or storage conditions.
   9. Unusual grounding-resistance conditions.
   10. Unusual space limitations.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Industries; Cooper Power Systems Division.
   2. GE Electrical Distribution & Control.
   3. Square D; Schneider Electric.
   4. Virginia Transformer Corp.

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

A. Description: ANSI C57.12.13, IEEE C57.12.00, pad-mounted, 2-winding transformers. Stainless-steel tank base.

B. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.

C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.

D. Basic Impulse Level: 60 kV.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. High-Voltage Switch: 200 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.

1. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
2. Internal liquid-immersed cartridge fuses.
3. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.

H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed.

I. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
1. Bushing-Well Inserts: One for each high-voltage bushing well.
2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
3. Parking Stands: One for each high-voltage bushing well.
4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

J. Accessories:
1. Drain Valve: 1 inch (25 mm), with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90.

B. Factory Tests: Perform the following factory-certified tests on each transformer:
1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
2. Ratios on rated-voltage connection and on tap extreme connections.
3. Polarity and phase relation on rated-voltage connection.
4. No-load loss at rated voltage on rated-voltage connection.
5. Excitation current at rated voltage on rated-voltage connection.
6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:
1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

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

3.2 INSTALLATION

A. Install transformers on concrete bases.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
   2. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

3.4 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."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
   1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
   2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Test Reports: Prepare written reports to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: If requested by Owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:
   1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
   2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

a) Adjust transformer taps.
b) Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
4. Report: Prepare written report covering monitoring and corrective actions performed.

B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the transformer.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and lists the results as follows:
   a) Description of equipment to be tested.
   b) Discrepancies.
   c) Temperature difference between the area of concern and the reference area.
   d) Probable cause of temperature difference.
   e) Areas inspected. Identify inaccessible and unobservable areas and equipment.
   f) Identify load conditions at time of inspection.
   g) Provide photographs and thermograms of the deficient area.
4. Act on inspection results according to the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

END OF SECTION

SECTION 26 24 16
262416

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective devices, surge suppression devices, accessories, and components indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a) Enclosure types and details for types other than NEMA 250, Type 1.
b) Bus configuration, current, and voltage ratings.
c) Short-circuit current rating of panelboards and overcurrent protective devices.
d) UL listing for series rating of installed devices.
e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports including the following:

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

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Procedures," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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 NEMA PB 1.

E. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a) Square D.
b) Eaton Corporation; Cutler-Hammer Products.

2.2 MANUFACTURED UNITS

A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
1. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
2. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
3. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

B. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.
2. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

D. Service Entrance Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

B. Main Overcurrent Protective Devices: Circuit Breaker.

C. Branch Overcurrent Protective Devices:
   1. For Circuit Breaker Frame Sizes 125A and Smaller: Bolt-on circuit breakers.
   2. For Circuit Breaker Frame Sizes Larger Than 125A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: 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. GFCI Circuit Breakers: Single- and two-pole configurations with 5-30mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

   1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.7 SURGE PROTECTION DEVICES

A. Listed and Component recognized in accordance with UL 1449 to include Section 37.3 highest fault current category. SPD devices shall be UL 1283 listed.

B. Provide surge current diversion paths for all modes of protection: l-N, L-G, and N-G in WYE systems.

C. Modular in design. Each mode, including N-G, shall be fused with a 200kAIR UL-classified surge-related fuse and incorporate a thermal cutout device.

D. Provide audible diagnostic monitoring by way of audible alarm. Alarm shall activate upon a fault condition. Provide push-to-test switch, and alarm on/off switch to silence alarms.

E. If a dedicated breaker for SPD is not provided, the SPD shall include a UL-classified disconnect switch.

F. Meet or exceed the following criteria:
   1. Minimum surge current capability (single pulse rated) per phase. 160 kA.
   2. UL 1449 suppression voltage rating, voltage L-N, L-G, N-G 208Y/120V; 400V; 480Y/277V;600V.

G. EMI/RFI Filtering: Minimum -50dB at 100 kHz with insertion ration of 50:1 using MIL-STD-220A methodology.

H. Provide with one set of NO/NC dry contacts.

I. Accessories:
   1. Six digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125V.
   2. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
   3. Audible alarm activated on failure of any surge diversion module.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.(27-GRC)

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section “Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. 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. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 7-1/2 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 27 26
262726

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Single and duplex receptacles, ground-fault circuit interrupters, and weather resistant receptacles.
   2. Single-, double-pole, 3-way and 4-way toggle switches and dimmer switches.
   3. Device wall plates.
   4. Pin and sleeve connectors and receptacles.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. PVC: Polyvinyl chloride.

D. RFI: Radio-frequency interference.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.4 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

      a) Cooper Wiring Devices.
      b) Hubbell Incorporated; Wiring Device-Kellems.
      c) Leviton Mfg. Company Inc.
      d) Pass & Seymour/Legrand

2.2 RECEPTACLES

A. Straight-Blade-Type Receptacles: Heavy-Duty Specification Grade. Comply with NEMA WD 1, NEMA WD 6, Fed. Spec. W-C-596G, and UL 498. Configuration NEMA 5-20R, 125V duplex receptacle.

B. Twist-Locking Receptacles: Heavy-Duty Specification Grade. Single Convenience Receptacles, 125 V, 250V, 125/250V, or 120/208V as required. Comply with NEMA WD 1, NEMA WD 6, and UL 498. NEMA Configuration as required to match the rating of the equipment served.

C. GFCI Receptacles: Straight blade, Heavy-Duty Specification Grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.

D. Weather Resistant Receptacles: Straight blade, Extra Heavy-Duty Specification Grade, weather resistant, comply with NEMA WD 1, NEMA WD 6, Fed. Spec. W-C-596G, NEC 406.8(A) and 406.8(B), and UL 498. Configuration NEMA 5-20R, 125V duplex receptacle listed as weather resistant type.

E. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.

2.3 PENDANT CORD/CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.
   1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
   2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 SWITCHES

A. Single- and Double-Pole Switches: 120/277 V, 20 A; Comply with Fed. Spec. W-C-896F and UL 20.

B. Toggle Switches: Heavy -Duty grade, quiet type.

C. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters. Switch type shall meet ADA requirements.
   1. Control: Continuously adjustable slider toggle switch; with single-pole or three-way switching to suit connections.(130-mm)
   2. Fluorescent Lamp Dimmer Switches: Modular; compatible with submitted dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

   3. LED Dimmer Switches: Modular, compatible with submitted dimming LED luminaire & driver; dimmer-driver combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished stainless steel.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Wet Locations: Cast aluminum or polycarbonate, and listed and labeled for use in wet locations while “In Use.”

2.7 FINISHES

A. Color:

1. Wiring Devices Connected to Normal Power System: Ivory, unless another color is selected by Architect, or required by NFPA 70.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies level, plumb, and square with building lines.

B. Wrap wiring devices with insulating tape before installing and placing plates.

C. 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.

D. Remove wall plates and protect devices and assemblies during painting.

E. All 15- and 20-ampere, 125- and 250-volt nonlocking receptacles installed in damp and wet locations shall be a listed weather-resistant type.

F. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.

3.2 IDENTIFICATION

A. Comply with Division 26 Section “Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION

SECTION 26 28 13
262813

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches and controllers

1.2 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.3 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (4.4 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.4 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Industries, Inc.; Bussmann Div.
2. Eagle Electric Mfg. Co., Inc.
3. Ferraz Shawmut, inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Motor Branch Circuits: Class RK5, time delay.

B. Other Branch Circuits: Class RK5, time delay.

C. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 26 28 16
262816

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:

1. Motor and equipment disconnecting means.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.
2. Division 26 Section "Fuses" for fusible devices.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. RMS: Root mean square.

C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switch and circuit breaker.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a) Enclosure types and details for types other than NEMA 250, Type 1.
b) Current and voltage ratings.
c) Short-circuit current rating.
d) UL listing for series rating of installed devices.
e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Field Test Reports: Submit written test reports and include the following:

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

D. Manufacturer's field service report.

E. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 01. In addition to requirements specified in Division 01 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for components.

2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA AB 1 and NEMA KS 1.

C. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

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

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2000 m).

1.6 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Fusible and Non-Fusible Switches:
   a) Square D; a brand of Schneider Electric.
   b) Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. Molded-Case Circuit Breakers:
   a) Square D Co., a brand of Schneider Electric.
   b) Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2.2 ENCLOSED SWITCHES

A. Enclosed, Non-fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, lockable handle for up to two padlocks, and interlocked with cover in the closed position.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle for up to two padlocks, and interlocked with cover in the closed position.

C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Molded-Case Circuit Breaker: NEMA AB 1, 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.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws, as specified in Division 26 Section “Identification for Electrical Systems.”

3.4 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

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

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
2. Test continuity of each line- and load-side circuit.
3. Inspect mechanical and electrical connections.
4. Verify rating of installed fuses.

B. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, perform the following field tests and inspections and prepare test reports:

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. 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.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 29 13
262913

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes ac general-purpose controllers rated 600 V and less that are supplied as enclosed units.

B. Related Sections include the following:

1. Division 26 Section "Fuses" for fuses to be used in combination controllers with fusible disconnect switch.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a) Enclosure types and details.
b) Nameplate legends.
c) Short-circuit current rating of integrated unit.
d) UL listing for series rating of overcurrent protective devices in combination controllers.
e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Field Test Reports: Written reports specified in Part 3.

D. Manufacturer's field service report.

E. Operation and Maintenance Data: For enclosed controllers and components to include in maintenance manuals specified in Division 01. In addition to requirements specified in Division 01 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain enclosed controllers of a single 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 NFPA 70.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.5 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Manual and Magnetic Enclosed Controllers:

    a) Square D Co.
    b) Eaton Corp.; Cutler-Hammer Products.

2. Variable-Frequency Controllers:

    a) ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
    b) Pre-approved equal.

2.2 MANUAL ENCLOSED CONTROLLERS

A. Description: NEMA ICS 2, general purpose, Class A, with toggle action and overload element.

2.3 MAGNETIC ENCLOSED CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

B. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Control transformer to be provided with (2) primary and (1) secondary fuses.

C. Combination Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.

D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

2.4 VARIABLE-FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, pulse-width-modulated, variable-frequency controller; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Isolation Transformer: Match transformer voltage ratings and capacity to system and motor voltages; and controller, motor, drive, and load characteristics.

D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

E. Starting Torque: 100 percent of rated torque or as indicated.

F. Speed Regulation: Plus or minus 1 percent.

G. Ambient Temperature: 0 to 40 deg C.

H. Efficiency: 95 percent minimum at full load and 60 Hz.

I. Minimum Displacement Power Factor at Input Terminals: 95 percent.

J. Isolated control interface allows controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.
2. Pneumatic Signal: 3 to 15 psig (20 to 104 kPa).

K. Internal Adjustability: Include the following internal adjustment capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to 22 seconds.
4. Deceleration: 2 to 22 seconds.
5. Current Limit: 50 to 110 percent of maximum rating.

L. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

M. Self-protection and reliability features shall include the following:

1. Input transient protection by means of surge suppressors.
2. Snubber networks to protect against malfunction due to system voltage transients.
3. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 10 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous overcurrent trip.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Under- and overvoltage trips.
9. Overtemperature trip.
10. Short-circuit protection.

N. Automatic Reset/Restart: Attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Restarting during deceleration shall not damage controller, motor, or load.

O. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.

P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.

3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

Q. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate controller output current, voltage, and frequency.

S. Manual Bypass: Magnetic contactor shall be arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass, selector-switch indicator lights set and indicate mode selection.

T. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

U. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

V. Isolating Switch: Non-load-break switch arranged to isolate variable-frequency controller and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

W. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.5 ENCLOSURES

A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel.

2.6 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty with digital readout in hours.

2.7 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

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

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. See Division 26 Section "Common Work Results for Electrical" for general installation requirements.

B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Common Work Results for Electrical."

C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 IDENTIFICATION

A. Identify enclosed controller components and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electric Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in Division 26 Section “Raceways and Boxes for Electrical Systems.”

B. Ground equipment.

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

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: Perform the following field tests and inspections, and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16.
2. Certify compliance with test parameters.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 CLEANING

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.10 STARTUP SERVICE

A. Verify that enclosed controllers are installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers and variable-frequency drives.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 26 51 00
265100

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Interior lighting fixtures with lamps and ballasts and/or LED drivers.
   2. Lighting fixtures mounted on exterior building surfaces.
   3. Emergency lighting units.
   4. Exit signs.
   5. Accessories, including dimmers and occupancy sensors.

B. Related Sections include the following:
   1. Division 26 Section "Wiring Devices" for manual light switches and manual wall-box dimmers.
   2. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.2 DEFINITIONS

A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.

B. CRI: Color rendering index.

C. CCT: Correlated color temperature.

D. CU: Coefficient of utilization.

E. LPW: Luminaire per watt, system efficacy.

F. RCR: Room cavity ratio.

G. LED: Light emitting diode.

H. L_{70}: Lumen depreciation to 70% of initial lumen output.

1.3 SUBMITTALS

A. In conjunction with the interior lighting submittal provide, simultaneously, the lighting control submittal package, as indicated in 26 09 23 “Lighting control devices” specification section.

B. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of fixture, including dimensions and verification of indicated parameters.
   2. Emergency lighting unit battery and charger.
   3. Complete fixture catalog number designation.
   4. LED:
      a) CCT, CRI
      b) Delivered lumen output
      c) Driver
         1) Drive current
      d) LPW
      e) Photometric data

C. Wiring Diagrams: Power, signal, and control wiring.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Procedures," include the following:

1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.

G. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate luminaire with submitted ceiling system for appropriate mounting accessory(s).

1.6 WARRANTY

A. Special Warranty for Emergency Lighting Unit Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

B. Warranty for LED: Manufacturer and Installer agree to repair or replace components of luminaires 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 LIGHTING FIXTURES

A. Fixtures and Components, General:

1. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
2. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
3. Metal Parts: Free of burrs and sharp corners and edges.
4. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
5. 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.
6. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   a) White Surfaces: 85 percent.
   b) Specular Surfaces: 83 percent.
   c) Diffusing Specular Surfaces: 75 percent.
7. Plastic Diffusers, Covers, and Globes:
8. 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 different thickness is scheduled.
   b) UV stabilized.
9. Glass: Annealed crystal glass, unless otherwise indicated.

B. For all luminaires provide the product specified in the lighting schedule.

2.2 EXIT SIGNS

A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
   1. Contractor shall provide an additional ten percent of the total exit signs to be installed at the direction of the A/E, or the authority having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: Light-emitting diodes (LED), 70,000 hours minimum of rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
   2. Charger: Fully automatic, solid-state type with sealed transfer relay.
   3. 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.
   4. Light-emitting diodes (LED), 70,000 hours minimum of rated lamp life.

2.3 EMERGENCY LIGHTING UNITS

A. General: Self-contained units complying with UL 924.
   1. Battery: Sealed, maintenance-free, lead-calcium type with minimum 5-year nominal life and special warranty.
   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. Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.
   5. Contractor shall provide ten percent of total emergency lighting units to be installed at the direction of the A/E or authority having jurisdiction.

2.4 LED LUMINAIRES

A. Maintain color consistency and light intensity across multiple fixtures of the same designation and those with the same family.

B. Design luminaires with heat sinking adequate such that the junction temperature of the LED's is maintained to meet the rated life as published by the LED manufacturer.

2.5 LED LIGHT SOURCES (LED PACKAGES, ARAYS OR MODULES)

A. Minimum Color Rendering Index of 70.

B. Bin LED's so that all luminaires of the same type have closely-matched color and lumen output characteristics so that they shall be within 4 Mc Adams ellipse steps.

C. Efficacy: 80 Lumens per watt unless otherwise indicated.

D. L_{70}: 50,000 hours minimum.

E. CCT: 3500K or as indicated.

2.6 LED POWER SUPPY

A. Performance Requirements:
   1. Operate LED's within the current limit specifications for the LED manufacturer.
   2. Operate at 60Hz input source and have input power factor above 90% and a minimum efficiency of 70% at full rated load of the driver.
   3. Provide short circuit and overload protection.

B. Regulatory Requirements:
   1. Contain no PCB's (polychlorinated biphenyl).
   2. Comply with IEEE C.62.41-1991, Class A operation.
   3. Be UL1310/8750 recognized when used in conjunction with a UL listed luminaire.

2.7 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Common Work Results for Electrical" for channel- and angle-iron 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, 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. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.8 FINISHES

A. Fixtures: Manufacturers' standard, unless otherwise indicated.
   1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
   2. Metallic Finish: Corrosion resistant.

2.9 SOURCE QUALITY CONTROL

A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

B. Factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

PART 3 EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
   1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from fixture corners.
   2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

C. Suspended Fixture Support: As follows:
   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: Suspend from cable. Use a separate cable for each unit length of fixture chassis, including one at each end

D. Adjust aimable fixtures to provide required light intensities.

3.2 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 and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of each fixture after installation.

C. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

D. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

F. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

G. Provide field adjustments to sensors after occupancy.

END OF SECTION

SECTION 265600
EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Exterior luminaires with lamps and ballasts or LED drivers.
   2. Lighting poles and standards, and other support structures for pole mounted exterior luminaries.

B. Related Sections include the following:
   1. Division 03 Section "Cast-In-Place Concrete" for concrete, reinforcement, and formwork required for concrete bases.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. LED: Light Emitting Diode

D. L_{70}: Lumen depreciation to 70% of initial lumen output.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. Pole: Luminaire support structure, including tower used for large area illumination.

1.3 SUBMITTALS

A. Product Data: For each luminaire, arranged in the order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of fixture, including dimensions and verification of indicated parameters.
   2. Luminaire dimensions, effective projected area, details of attaching luminaires, accessories, and installation and construction details.
   3. Luminaire materials.
   4. Complete catalog number designation as well as the following:
      a) LED
         1) CCT, CRI
         2) Delivered lumen output
         3) Driver
         4) Drive current
         5) LPW
         6) Photometric data
   5. .Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
   6. Anchor bolts for poles.

B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer

C. Field quality-control test reports.

D. Operation and Maintenance Data: For luminaires to include in maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

B. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace luminaires or components of luminaires and lamps that fail in materials or workmanship; corrode; or fade, stain, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
   a) Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
   b) Warranty Period for Color Retention: Five years from date of Substantial Completion.
   c) Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.
2. Special Warranty for LED drivers: Manufacturer's standard form in which driver manufacturer agrees to repair or replace driver that fail in materials or workmanship within specified warranty period.
   a) Warranty Period for driver: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 LUMINAIRES, GENERAL

A. UL reports that UL 1572 in paragraph below will be replaced by UL 1598 on January 31, 2001.

B. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction. Where LER is specified, test according to NEMA LE 5B.

C. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

G. 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.

H. Exposed Hardware Material: Stainless steel.

I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

J. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

K. 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.

L. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

M. 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.

N. 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.

O. Label shall include the following lamp and ballast characteristics:
   1. “USES ONLY" and include specific lamp type.
   2. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
   3. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
   4. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
   5. ANSI ballast type (M98, M57, etc.) for HID luminaires.
   6. CCT and CRI for all luminaires.

P. For all luminaires provide the product specified in the lighting schedule or an equal product that meets the performance requirements listed within the specifications. Equals are subject to design team’s acceptance.
   1. Equal shall have the same aesthetic qualities and appearance as the specified luminaire including, but not limited to, shape, dimensions, mounting, and finish.
   2. Fluorescent luminaires shall have the same efficiency within a 5% variation of the specified luminaire.
   3. LED luminaires:
      a) Shall have the same delivered Lumen output within a 5% variation of the specified luminaire.
      b) Lumen data must be per IES LM-79 & 80.
      c) Lumen data must be based on equal drive current to specified fixture.
      d) Lumen data must be calculated at the same CCT as specified luminaire.
      e) Shall have the same efficacy within a 5% variation of the specified luminaire.
      f) Shall have the same input wattage within a 5% variation of the specified luminaire.
   4. Provide photometric calculations for equals for typical areas upon request.
      a) Include in provided calculations LLF utilized.
      b) LLF for LED: .72 LLF.
      c) LLF for Fluorescent: .9-1.0 unless otherwise specified.
   5. Equals shall have the same electrical components as the specified luminaire including but not limited to the following:
      a) Lamping including number, type and layout within fixture (staggered or not).
      b) Distribution.
      c) Voltage.

d) Ballast shall be of the same type as listed in the schedule including ballast factor.
e) Driver shall be of the same type as listed in the schedule including Drive current.

2.2 LED LUMINAIRES

A. Maintain color consistency and light intensity across multiple fixtures of the same designation and those with the same family with characteristics in accordance with ANSI C78.377-2008 as a minimum.

B. Design luminaires with heat sinking adequate such that the junction temperature of the LED's is maintained to meet the rated life as published by the LED manufacturer.

2.3 LED LIGHT SOURCES (LED PACKAGES, ARAYS OR MODULES)

A. Minimum Color Rendering Index of 70.

B. Bin LED's so that all luminaires of the same type have closely-matched color and lumen output characteristics so that they shall be within 4 Mc Adams ellipse steps.

C. Efficacy: 50 Lumens per watt unless otherwise indicated.

D. L_{70}: 50,000 hours minimum.

E. CCT: 4000-4100K.

2.4 LED POWER SUPPLY

A. Performance Requirements:
1. Operate LED's within the current limit specifications fo the LED manufacturer.
2. Operate at 60Hz input source and have input power factor above 90% and a minimum efficiency of 70% at full rated load of the driver.
3. Provide short circuit and overload protection.
4. Provide dual level high low driver

B. Regulatory Requirements:
1. Contain no PCB's (polychlorinated biphenyl).
2. Comply with IEEE C.62.41-1991, Class A operation.
3. Be UL 1310/8750 recognized when used in conjunction with a UL listed luminaire.

2.5 FACTORY FINISHES

A. Factory-Painted 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. Interior Surfaces: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
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: Match Architect's sample of custom color.
   b) Color: As selected by Architect from manufacturer's full range.

B. 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.

3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.6 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 Division 03 Section "Cast-in-Place Concrete."
   1. Provide 3/4" X 10'-0" ground rods in the pole foundation so that the ground rod projects 3" up into center of pole base.
   2. The exposed surface area of the foundation shall have the forms removed and the concrete rubbed out to a smooth finish.

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.
   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 luminaire.

PART 3 EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Luminaire Attachment: Fasten to indicated structural supports.

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.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet (5 m) from tree trunk.

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 Division 03 Section "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. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. 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. Raise and set poles using web fabric slings (not chain or cable).

3.3 CORROSION PREVENTION

A. Steel Conduits: Comply with Division 26 Section "Raceway 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.

3.4 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "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.

3.5 CONNECTIONS

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

3.6 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
   a) IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
   b) IESNA LM-64, "Photometric Measurements of Parking Areas."

D. 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

SECTION 27 05 26
270526

PART 1 GENERAL

1.1 SUMMARY

A. The purpose of the grounding system is to create a low impedance path to earth ground for electrical surges and transient voltages. Lightning, fault currents, circuit switching (motors turning on and off), and electrostatic discharge are common causes of these surges and transient voltages. An effective grounding system minimizes the detrimental effects of these electrical surges, which include degraded network performance and reliability and increased safety risks.

B. The grounding system must be intentional, visually verifiable, adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment. As such, grounding must be purposeful in its design and installation. Four issues require special consideration:

1. Although AC powered equipment typically has a power cord that contains a ground wire, the integrity of this path cannot be easily verified. Thus, many equipment manufacturers require grounding above and beyond that which is specified by local electrical codes, such as the National Electrical Code, etcetera. Always follow the grounding recommendations of the manufacturer when installing equipment.
2. While the building steel and metallic water piping must be bonded to the grounding system for safety reasons, neither may be substituted for the telecommunications bonding backbone (TBB).
3. Electrical continuity throughout each rack or cabinet is required to minimize safety risks. Hardware typically supplied with bolt-together racks is not designed for grounding purposes. Additionally, most racks are painted. Paint is an insulator. Unless rack members are deliberately bonded, continuity between members is incidental, and in many cases, unlikely.
4. Any metallic component that is part of the data center, including equipment, racks, ladder racks, enclosures, cable trays, etc. must be bonded to the grounding system.

1.3 DEFINITIONS

A. Bonding – The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

B. Common Bonding Network (CBN) – The principal means for affecting bonding and earthing inside a building.

C. Ground – A conducting connection, whether intentional or incidental, by which an electric circuit or equipment is connected to earth, or to some conducting body of relatively large extent that serves in place of the earth.

D. Retrofit Rack Grounding – Racks where functioning equipment is already deployed in a way that impedes rack grounding system installation.

1.4 WORKMANSHIP

A. The ground system must be designed for high reliability. Therefore, the grounding system shall meet following criteria:

1. Local electrical codes shall be adhered to.
2. The grounding system shall comply with J-STD-607-A, IEEE Std. 1100, and the pending industry standard ANSI/TIA-942, Draft 7.0.
3. All grounding conductors shall be copper.
4. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and CSA Certified and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.

5. Wherever possible, two-hole lugs shall be used because they resist loosening when twisted (bumped) or exposed to vibration. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion (battery rooms are an exception where windowless lugs may be used).
6. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
7. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.

1.5 RELATED WORK

A. Section 26 05 00 – Common Work Results for Electrical

B. Section 27 05 28.33 – Conduits and Back Boxes for Communications

C. Section 27 05 44 - Sleeves and Sleeve Seals for Communications Pathways and Cabling

D. Section 27 10 00 – Structured Cabling

E. Section 27 11 00 – Communications Equipment Room Fittings

1.6 WORK SEQUENCE

A. During the construction period, coordinate telecommunications grounding and operations with the Architect/Engineer and Owner.

B. For additional information pertaining to the sequencing of the work refer to Article 13 of the General Conditions.

C. Installation shall be sequenced to accommodate the Owner's occupancy requirements. See Division 01, General Conditions (Work Sequence).

1.7 SUBMITTALS

A. Under the provisions of Division 26 and Division 01, prior to the start of work the Contractor shall submit:

1. Six (6) sets of Manufacturers Data covering all products proposed indicating construction, materials ratings and all other parameters identified in Part 2 (Products) below.
2. Manufacturer's installation instructions.

B. Submittals shall be grouped to include complete documentation of related systems, products and accessories in a single submittal. Where applicable, dimensions should be marked in units to match those specified.

C. Submittals shall be original catalog sheets or photocopies thereof. Facsimile (fax) sheets shall not be accepted.

D. Two sets of submittals. The Engineer shall review the Submittals and annotate them indicating approvals and shall return to the contractor.

E. Work shall not proceed without the Engineer's approval of the submitted items.

F. If materials are furnished as specified no further qualifications is necessary, except for items requiring shop drawings. However, if the contractor wishes to substitute another manufacturer and/or catalog, the following information in triplicate shall be submitted to the Engineer.

1. A complete description of the material which the contractor proposes to substitute (shop drawings, illustrations, catalog data, performance characteristics, etc.) and the reason for the substitution identifying any benefit to the Owner.

G. The Contractor shall receive approval from the Engineer on all substitutions of material, No substituted materials shall be installed except by written approval from the Engineer.

1.8 PROJECT RECORD DOCUMENTS

A. Submit and record documents under provisions of Division 01.

B. Accurately record exact sizes, locations, and quantities of cables.

1.9 QUALITY ASSURANCE

A. The manufacturer shall be a company specializing in communication cable and/or accessories with a minimum of five years documents experience in producing cable and/or accessories similar to those specified below.

B. The Contractor shall have been in this line of business for a minimum of five (5) years and completed four (4) jobs of the magnitude specified in the following sections.

C. The installing contractor shall have at a minimum one (1) Certified Installer trained to the latest industry standards to ensure the most reliable installation available. The certified installer shall have been trained by a company that offers a minimum fifteen (15) year system warranty.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to and receive products at the site under provisions of Division 01, General Requirements.

B. Cable shall be stored according to manufacturer's recommendation as minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location.

C. If the contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the owner. If necessary, cable shall be stored off site at the contractor's expense.

PART 2 PRODUCTS

2.1 COMPONENTS, KITS, AND HARDWARE

A. PANDUIT STRUCTUREDGROUND grounding system, kits, components, and hardware shall be used to construct the grounding/earthing system.

B. Use PANDUIT GB4 series BICSI/J-STD-607-A telecommunications grounding busbars for the TMGB, which is ideally located at the AC service entrance. Use a PANDUIT GB2 series busbar for the TGB in each of the other telecommunications/equipment spaces throughout the building. Use PANDUIT LCC-W series lugs when connecting conductors to the TMGB and TGB.

C. Route the TBB to each TGB in as straight a path as possible. The TBB should be installed as a continuous conductor, avoiding splices where possible. Use PANDUIT HTAP kits, family HTWC, to provide a tap from the TBB to each TGB. When more than one TBB is used, bond them together using the TGBs on the top floor and every third floor in between with a conductor known as a grounding equalizer (GE). Use the J-STD-607-A guidelines for sizing of the TBB when sizing the GE (shown in the table above).

D. Avoid routing grounding conductors in metal conduits. If the grounding conductor must be routed through a metal conduit, bond each end of the conduit to the grounding conductor. Use PANDUIT GPL series grounding clamps to bond to the conduit, a PANDUIT HTWC HTAP with clear cover to bond to the grounding conductor, and a #6 AWG copper conductor to connect the GPL grounding clamp to the HTWC HTAP.

2.2 RACK GROUNDING

A. Equipment and racks shall be bonded in accordance with the methods prescribed in ANSI/TIA-942 draft 7.0, as is shown in the figure below.

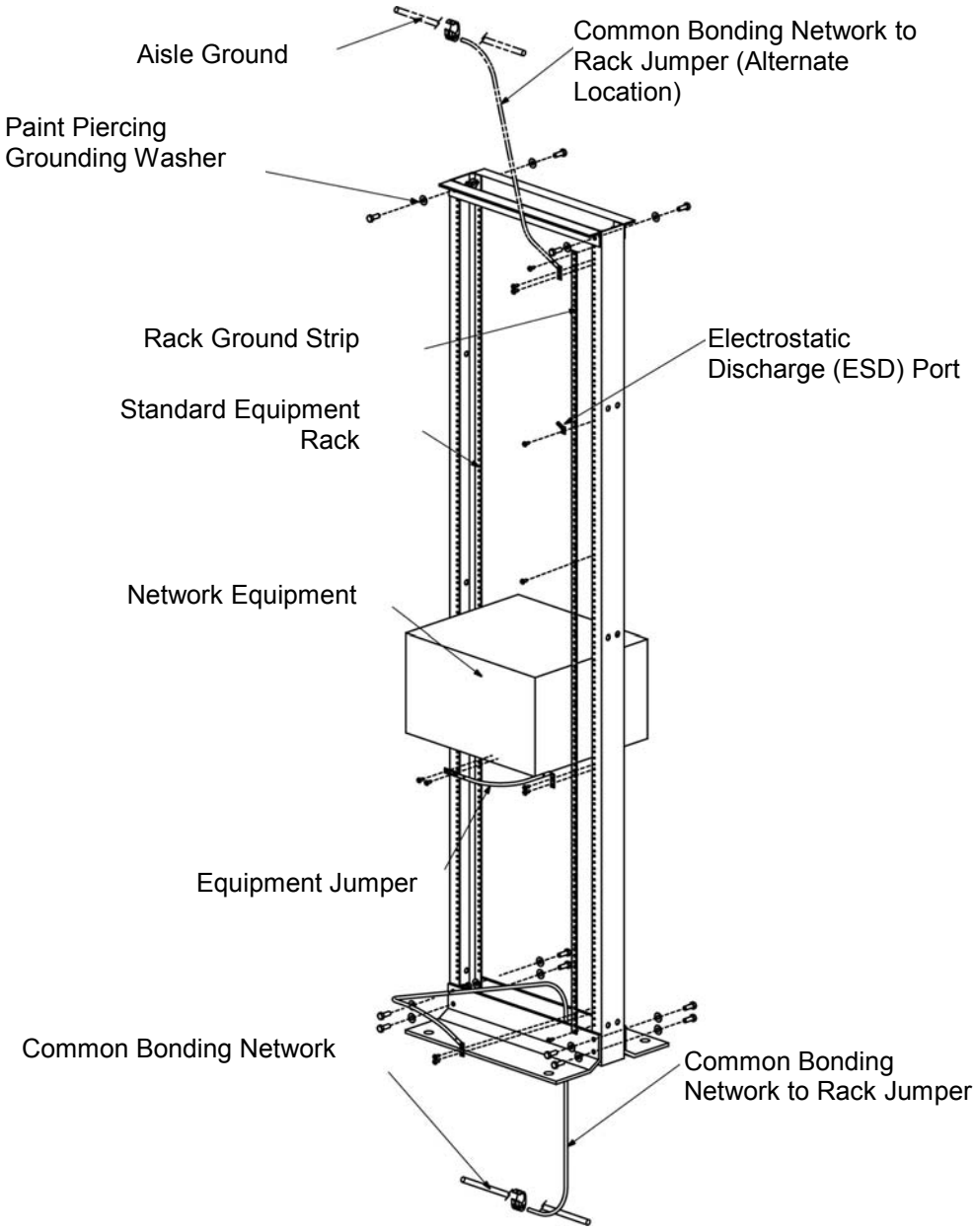

Figure 1 - Properly Grounded Rack (Back of Rack Shown)

B. To provide electrical continuity between rack elements, PANDUIT paint piercing grounding washers, series RGW, shall be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.

C. All racks shall utilize a full-length rack ground strip, PANDUIT part number RGS134, attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact.

D. Mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGESD-1 directly to the rack grounding strip on the back of the rack at approximately 48 inches from the floor. Mount a second RGESD-1 directly to the vertical mounting rail of the rack in the front at approximately the same height. Use the thread-forming screws provided to form a bond to the rack. Place the ESD protection identification stickers directly above the ESD ports.

E. When the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. Use the appropriate PANDUIT RG series jumper for the equipment being installed and the thread-forming screws provided in the kit.

F. Use PANDUIT part number RGCBNJ660P (Common Bonding Network to Rack Jumper) to attach the rack ground strip to the common bonding network. Do not bond racks or cabinets serially. Use the copper compression HTAP that comes with the kit to bond the conductor to the common bonding network.

G. Patch panels will be bonded to racks using the PANDUIT bonding screws, part number RGTBS-C for racks having #12-24 equipment mounting holes, and RGTBSM6-C for racks having M6 equipment mounting holes.

PART 3 EXECUTION

3.1 GROUNDING AND BONDING

A. The Telecommunications Grounding Busbar (TGB) in each telecommunications space will be grounded to the Telecommunications Main Grounding Busbar (TMGB) located at the service entrance. The gauge of the connecting ground cable, known as the Telecommunications Bonding Backbone (TBB) will follow J-STD-607-A guidelines, as is shown in the table below.

Sizing of the TBB	
TBB Length in Linear meters (feet)	**TBB Size (AWG)**
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
Greater than 20 (66)	3/0

B. The TMGB will be bonded to building steel and grounded to the electrical service ground according to BICSI TDM Manual and J-STD-607-A guidelines. Local codes may supersede these requirements. In telecommunications spaces with only one rack, the rack jumper cable can be connected directly to the TGB.

Cable Sizes for Other Grounding Applications	
Purpose	**Copper Code Cable Size**
Aisle grounds (overhead or under floor) of the common bonding network	#2 AWG or larger (1/0 preferred)
Bonding conductor to each PDU or panel board serving the room.	Size per NEC 250.122 & manufacturer recommendations
Bonding conductor to HVAC equipment	6 AWG
Building columns	4 AWG
Cable ladders and trays	6 AWG
Conduit, water pipe, duct	6 AWG

END OF SECTION

SECTION 270528
270528

PART 1 GENERAL

1.1 SUMMARY

A. The electrical contractor shall provide rough-in for the following communication systems.
   1. Data Cabling System.
   2. Telephone System.
   3. Fiber Optic Cabling System.
   4. Public Address System.
   5. Building Security / Access Control System.
   6. Video Surveillance System

B. This Section includes providing raceways, fittings, boxes, enclosures, plywood backboards, sleeves and cabinets for low voltage wiring.

C. Related Sections include the following:

   1. Division 07 Section "Firestopping" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
   2. Division 26 Section "Underground Ducts and Raceways for Electrical" for exterior ductbanks, handholes, and underground utility construction.
   3. Division 26 "Wiring Devices" for devices installed in boxes and for floor-box service fittings.
   4. Division 27 “Grounding and Bonding for Communications Systems”.
   5. Division 27 “Sleeves and Sleeve Seals for Communications Pathways and Cabling”.
   6. Division 27 “Structured Cabling”.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. GRC: Galvanized rigid steel conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. RNC: Rigid nonmetallic conduit.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.4 COORDINATION

A. Coordinate layout and installation of raceways, boxes, cable tray, runways, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturer:

1. AFC Cable Systems, Inc.
2. Allied Tube and Conduit.
3. Electri-Flex Co.
4. O-Z/Gedney; a brand of EGS Electrical Group.
5. Republic Conduit.
6. Thomas & Betts Corporation.
7. Western Tube and Conduit Corporation.
8. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1 and UL 6.

C. IMC: ANSI C80.6.

D. EMT and Fittings: ANSI C80.3 and UL 797.

E. FMC: Zinc-coated steel, complying with UL 1.

F. LFMC: Flexible steel conduit with PVC jacket, complying with UL 360.

G. Fittings: NEMA FB 1 and UL 514B; compatible with conduit and tubing materials.

H. Finish:

1. Manufacturer's standard enamel finish.
2. Data and telephone: BLUE EMT
3. Fiber Optic: ORANGE EMT
4. Building security and access control: YELLOW EMT

2.2 NONMETALLIC CONDUIT AND FITTINGS

A. Manufacturer:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc
3. Cantex Inc.
4. Certainteed Corp.
5. Lamson & Sessions; Carlon Electrical Products.
6. RACO; Division of Hubbell, Inc.
7. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit type and material.

2.3 METAL WIREWAYS

A. Manufacturer:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D.
4. Wiegmann; Hubbell, Inc.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1, unless otherwise indicated, and sized according to NFPA 70.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturer:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Hoffman.
4. RACO; Division of Hubbell, Inc.
5. Spring City Electrical Manufacturing Co.
6. Thomas & Betts Corporation.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Floor Boxes: Cast metal, fully adjustable, rectangular.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Metal Enclosures, Type 4: Stainless steel.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

H. Cabinets:

1. NEMA 250, Type 1, 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.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: Rigid steel.
2. Concealed: Rigid steel.
3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R

B. Indoors:

1. Exposed, not subject to physical damage: EMT.
2. Exposed, and subject to severe physical damage: Rigid steel.
3. Concealed: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Rigid steel conduit.
6. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
   a) Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

C. Minimum Raceway Size: 3/4-inch trade size (DN 16).

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. EMT Conduit: Use steel set screw or compression.
2. Intermediate and Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated. Type with insulated throat (no cast).
3. Flexible conduit: Use only fittings listed for use with flexible conduit.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and hot-water pipes. Install horizontal raceway runs above water piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install temporary closures to prevent foreign matter from entering raceways.

F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

H. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

    1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

J. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.

    1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
    2. Space raceways laterally to prevent voids in concrete.
    3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
    4. Change from Schedule 40 nonmetallic conduit to rigid steel conduit, or IMC before rising above the floor.

K. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

    1. Run parallel or banked raceways together on common supports.
    2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

L. Join raceways with fittings designed and approved for that purpose and make joints tight.

    1. Use insulating bushings to protect conductors.

M. Tighten set screws of threadless fittings with suitable tools.

N. Terminations:

    1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.

2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

O. 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.

P. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

Q. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

R. Flexible Connections: Use maximum length of 24 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

S. Set floor boxes level and flush with finished floor surface.

T. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

U. Outlets:

1. Locations of data, telephone, TV outlets and communication equipment on the drawings are approximate only. Unless otherwise indicated on the drawings or established in the specifications, the exact locations of electrical outlets shall be established in the field by directive from the Architect. Generally, outlets shall be located as required for proper installation of equipment served and otherwise locations shall be established by construction or code requirements and such as to be coordinated with equipment of other trades.
2. This Section shall consult with the Architect and refer to all details, sections, elevations and equipment plans and the plans of other trades for exact location.
3. The Architect reserves the right to make reasonable changes in the location of outlets, apparatus or equipment up to the time of roughing in. Such changes as directed shall be made by the Contractor without additional compensation.
4. Dimensions taken by scale shall not be used to establish rough-in locations.
5. No back-to-back units, offset outlet boxes on opposite side of wall a minimum of 12 inches.

V. Communication Outlets Requirements:

1. The approximate location of communication devices are indicated on the drawings; the specific location shall be determined in accordance with “Location of Outlets” of these specifications and as follows:
   a) Telephone and Data outlet, 4” square deep box with 1 gang ring mount at 18” AFF
   b) (or at height indicated on plan). Extend ¾” conduit to accessible corridor ceiling.
   c) TV outlet, 4” square deep box with 1 gang ring mount at height indicated on plan. Extend ¾” conduit back to data rack or termination pull box.
   d) Telephone wall outlet, 4” sq deep box with 1gang ring mount at ADA guide lines for front, side or obstructed reach. Verify with Architect. If no obstructions and side accessible mount at 54” AFF. Extend ¾” conduit to accessible corridor ceiling space.

3.3 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 00 Firestopping.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

3.5 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 270544
SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.

B. Related Requirements:
   1. Division 07 Section " Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

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-steel sheet.
   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 pathway 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.

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 pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "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 pathway 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 pathways 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 pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway 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

SECTION 27 10 00
271000

PART 1 GENERAL

1.1 SUMMARY

A. This section describes the products and execution requirements relating to furnishing and installation of Telecommunications Cabling and Termination Components and related sub-systems as part of a structured cabling system. Vertical (Backbone) and horizontal (Station) cabling comprised of copper cabling are covered under this document.

B. The Horizontal (Station) Cabling System is based on the installation of 4-Pair Unshielded Twisted Pair (UTP) DATA/VOICE (Category 6) Copper Cables. The cables shall be installed from each Standard Information Outlet (SIO) to the Telecommunications Closet (TC) or Equipment Room (ER) serving that area and terminated as specified in this document.

C. Station cables shall be installed in conduit, or “free-air’ above accessible ceilings. Outlets shall be mounted flush in wall-mounted box. Information Outlet locations to be identified on the project drawings.

D. Backbone Copper and Fiber Optic Cables shall link the Equipment Rooms and/or Telecommunications Closets. Refer to the sub-section below detailing innerduct requirements for Fiber Optic Cables.

E. At the Main Telephone Equipment Room and at each TC, termination hardware related to Voice Cabling shall be wall mounted. At the Main Data Equipment Room and at each TC, data and fiber optic cable terminations shall be mounted on freestanding equipment racks.

F. All cables and related termination, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following sections.

G. The Contractor shall provide all labor and materials necessary to construct the system as described herein. This includes, but is not limited to, furnishing and installing cable, cable supports, innerduct, racking and termination components, termination, testing, labeling and documentation.

H. Basic Electrical Requirements are applicable to all Division 27 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.

1.2 RELATED WORK

A. Section 26 05 00 – Common Work Results for Electrical

B. Section 26 27 26 – Wiring Devices

C. Section 27 05 26 – Grounding and Bonding for Communications Systems

D. Section 27 05 28.33 – Conduit and Back Boxes for Communications

E. Section 27 05 44 – Sleeves and Sleeve Seals for Communication Pathways and Cabling

F. Section 27 11 00 – Communications Equipment Room Fittings

1.3 REGULATORY REFERENCES

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Wisconsin Electrical Code, and present manufacturing standards. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

B. Other applicable standards are as follows:

1. ANSI/EEE C2 – National Electrical Safety Code
2. NFPA 70 – National Electrical Code
3. IBC – International Building Code, as adopted by the Wisconsin Commercial Building Code
4. Wisconsin Administrative Code Chapter SPS 316 - Electrical
5. TIA/EIA Standards 526 – 14A (OFSPT – 14), 526-7 (OFSPT – 7)
6. TIA/EIA Standards 568-B, 569, and 607
7. IEEE/ANSI 142 – 1982 – Recommended Practice for Grounding of Industrial and Commercial Power Systems.

1.4 WORK SEQUENCE

A. During the construction period, coordinate telecommunications schedule and operations with the Architect/Engineer and Owner.

B. For additional information pertaining to the sequencing of the work refer to Division 01, General Requirements.

C. Installation shall be sequenced to accommodate the Owner's occupancy requirements. See Division 01, General Requirements.

1.5 SUBMITTALS

A. Under the provisions of Division 26 and Division 01, prior to the start of work the Contractor shall submit:
   1. Manufacturers Data covering all products proposed indicating construction, materials ratings and all other parameters identified in Part 2 (Products) below.
   2. Manufacturer's installation instructions.

B. Submittals shall be grouped to include complete documentation of related systems, products and accessories in a single submittal. Where applicable, dimensions should be marked in units to match those specified.

C. Submittals shall be original catalog sheets or photocopies thereof. Facsimile (fax) sheets shall not be accepted.

D. Work shall not proceed without the Engineer's approval of the submitted items.

E. If materials are furnished as specified no further qualifications is necessary, except for items requiring shop drawings. However, if the contractor wishes to substitute another manufacturer and/or catalog, the following information in triplicate shall be submitted to the Engineer.
   1. A complete description of the material which the contractor proposes to substitute (shop drawings, illustrations, catalog data, performance characteristics, etc.) and the reason for the substitution identifying any benefit to the Owner.

F. The Contractor shall receive approval from the Engineer on all substitutions of material. No substituted materials shall be installed except by written approval from the Engineer.

1.6 PROJECT RECORD DOCUMENTS

A. Submit and record documents under provisions of Division 01.

B. Accurately record exact sizes, locations, and quantities of cables.

1.7 QUALITY ASSURANCE

A. The manufacturer shall be a company specializing in communication cable and/or accessories with a minimum of five years documents experience in producing cable and/or accessories similar to those specified below.

B. The Contractor shall have been in this line of business for a minimum of five (5) years and completed four (4) jobs of the magnitude specified in the following sections.

C. The installing contractor shall have at a minimum one (1) Certified Installer trained to the latest industry standards to ensure the most reliable installation available. The certified installer shall have been trained by a company that offers a minimum fifteen (15) year system warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to and receive products at the site under provisions of Division 01, General Requirement.

B. Cable shall be stored according to manufacturer's recommendation as minimum. In addition, cable must be stored in a location protected from vandalism and weather. Cable shall not be stored outside. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location.

1.9 DRAWINGS

A. It shall be understood that the electrical and telecommunication details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the Contractor in bidding the job. The contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.

B. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.

C. Prior to submitting the bid, the Contractor shall call the attention of the Engineer to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted, within ten (10) days prior to the Bid Due Date.

PART 2 PRODUCTS

2.1 BACKBONE (RISER AND TIE) COPPER CABLING

A. Backbone Voice Cabling

1. The Voice Backbone Cable shall link the Main Equipment Room and TC's serving the building. These cables shall be terminated on 110 type blocks.
2. Voice Backbone Cable shall incorporate 24 AWG solid annealed Copper Conductors insulated with a polyvinyl chloride skin over expanded polyethylene. Conductors shall be twisted to form pairs and fully color-coded.
3. The Voice Backbone Cable shall be sized as detailed in Part 3 "Execution" of this section.
4. Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of ten (10) distinctive colors to identify 25 pairs in accordance with ICEA publication S-80576-1988. Marking of each mate of primary conductor in a pair with the color of that primary conductor is optional.
5. The Voice Backbone Cable shall meet or exceed the EIA/TIA Category 6 performance.
6. When cables of larger than 25 pairs are required, the core shall be assembled into 25-pair sub-units, each color-coded in accordance with ICEA publication S-80-576-1988. Cables with over 600 pairs shall have 25-pair binder groups combined into super units. These super units shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow and violet. Binder color code integrity shall be maintained wherever cables are spliced.
7. This cable shall meet or exceed NEC Article 800 Type CMR and be UL listed. Jacket shall be of fire resistant PVC. If this cable is installed in a Plenum area it shall meet or exceed NED Article 800 Type CMP and be UL listed.
8. All cables and equipment shall be furnished, installed, wired and tested by the Contractor.

2.2 BACKBONE FIBER OPTIC CABLE

A. General

1. Cables shall incorporate optical fibers meeting the specifications detailed in the sub-section(s) below. Backbone Fiber Optic Cable sizing (fiber count) shall be per Project Drawings.

B. Backbone Fiber Optic Cable

1. This cable shall be suitable for installation free-air, in building risers, in conduit, in cable tray and/or in innerduct.
2. Cable materials shall be all dielectric (no conductive materials).

3. Cabling shall carry OFNR rating (Optical Fiber Non-Conductive Riser) when installed in conduit and shall be listed as being suitable for use in a vertical run shaft or from floor to floor and shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor. An acceptable method of defining fire-resistant characteristics shall be that the cable passes the requirements of the Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts (ANSI/UL 1666-1986).

C. Outer Sheath
   1. The Outer Sheath shall be marked with the manufacturer's name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.

D. Temperature Range
   1. Storage: -40 to +70 degrees C (no irreversible change in attenuation)
   2. Operating -20 to +70 degrees C (OFNR)

E. Humidity Range: 0 to 100%

F. Max. Tensile Load ($\geq$ 12-fibers; Backbone Intra-building)
   1. During Installation: 1332 Newton's (300 lb. force) (no irreversible change in attenuation)
   2. Long Term: 600 N (135 lb. force)

G. Bending Radius
   1. During Installation: 20 times cable diameter
   2. No Load: 10 times cable diameter

H. Optical Fiber Specifications (General)– Backbone Cable
   1. The fiber count in each cross-section will vary. For quantities and other design information, refer to the Project Drawings and Execution Section.
   2. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification. Factory optical fiber splices are not allowed.
   3. All fibers shall have been subjected to a minimum tensile proof test by the fiber manufacturer equivalent to 100-kpsi.
   4. All fibers in each cable shall be guaranteed to meet the stated specifications.

I. Multi-mode Optical Fibers
   1. Multi-mode Optical Fibers in each cable shall meet the following specifications:
      a) Fiber Type Multi-mode; doped silica core surrounded by a concentric glass cladding
      b) Index Profile Graded Index
      c) Transmission Windows 850-nm and 1300-nm
      d) Core Diameter (nom) 50-µm (microns)±3
      e) Cladding Diameter 125-µm±2
      f) Core –clad Concentricity $\leq$ 3-µm
      g) Cladding Non-circularity $\leq$2.0%
   2. Fiber Coating Diameter 250 -µm ± 15 (primary coating)
      a) All coatings shall be mechanically strippable without damaging the optical fiber.
   3. Attenuation (max. @ 23±5 degrees C; Backbone)
      a) @ 850-nm 3.75-dB/km
      b) @1300-nm 1.5-dB/km
   4. Changes to multi-mode fiber shall show a point of discontinuity greater than 0.2dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that fiber by the Owner.
   5. Bandwidth (min.)
      a) @850-nm200MHz*km
      b) @1300-nm 500MHz*km
   6. No multi-mode optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of the fiber by the Owner.

2.3 HORIZONTAL MEDIA (STATION CABLES)

A. General

1. All horizontal Data Station Cables shall terminate on modular Patch Panels in their respective Telecommunications Closets (TC) or Equipment Room (ER) as specified on the drawings.
2. Transmission characteristics of the Data Station Cables shall meet full Category 6 performance criteria as defined by the referenced TIA/EIA documents. Refer to the Execution Section which details the required performance criteria of the completed link of which the cable is a part.
3. Important: Cable and termination components (jack, patch panel, wiring, blocks) are specified to function as a system. The compatibility of the cable to be installed with the proposed termination components shall be recognized and documented by the termination component manufacturer.
4. The jacket color for Data cabled shall be BLUE.
5. Cable shall be packaged in a way that minimizes tangling and kinking of the cable during installation. Examples are open reels or packages that incorporate a rotating reel.

B. Horizontal Voice Station Cable (Copper)

1. All horizontal voice station cables shall terminate on 110 type wall mounted termination blocks in their respective TC or ER as specified on the drawings.
2. All cables, termination components and support hardware shall be furnished, tested, installed and wired by the Contractor.
3. Transmission characteristics of the voice station cables shall meet full Category 6 performance as defined by the referenced TIA/EIA documents.
4. The cable shall meet the following specifications:
   a) Twisted pair 24 gauge
   b) Impedence 100 ohms +/- 15% @ 1MHz
   c) Attenuation 2.6 dB/100 meters @ 1 MHz
5. The jacket color for “voice” cables shall be WHITE.
6. Cable shall be packaged in a way that minimizes tangling and kinking of the cable during installation. Examples are open reels or packages that incorporate a rotating reel.

2.4 INFORMATION OUTLET

A. General

1. Station cables shall each be terminated at their designated workstation location in the connector types described in the sub-sections below. Included are modular jacks (Voice & Data). These connector assemblies shall snap in to a mounting frame. The combined assembly is referred to as the Standard Information Outlet (SIO).
2. SIO mounting configurations shall be as follows:
   a) Flush mounted.
   b) All faceplates shall have the jacks loaded from the rear. Front-loaded faceplates will not be acceptable.
3. The Telecommunications Outlet Frame shall accommodate:
   a) A minimum of four (4) modular jacks when installed in a wall-mounted assembly. The top two positions shall be utilized for the voice jacks and the bottom two positions shall be utilized for the data jacks.
   b) A minimum of four (4) modular jacks when installed in a floor-mounted assembly.
   c) A minimum of two (2) modular jacks when installed on modular furniture.
   d) The Voice outlet shall be: 8-pin modular, Category 6, unkeyed, Fog White pinned to T568 (B) standards.
   e) The Data outlet shall be: 8-pin modular, Category 6, unkeyed, Fog White, pinned to T568 (B) standards.
   f) The outlet frame shall incorporate a mechanism for adjusting the surface plate to a plumb position.
4. Multiple Jacks- identified in close proximity on the drawings (and not separated by a physical barrier) – may be combined in a single assembly. The contractor shall be responsible for determining the optimum compliant configuration based on the products proposed and documented these in the as-built records.

5. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each SIO type for review by the Engineer.
6. Wall Mount Outlet Faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
7. Where stand-alone "Data" or "Voice" only jacks are identified, the SIO Frame shall be configured as to allow for the addition of one (1) additional jack (voice or data) to be installed to supplement each such jack as defined by this project. The installation of these supplemental jacks is NOT part of this project.
8. Any unused jack positions shall be fitted with a removable blank inserted into the opening.
9. The faceplate of the SIO shall be constructed of High Impact Plastic. Faceplate color shall be Fog White.
10. Wall-mounted "Voice Only" outlets shall be installed where identified on the floorplan drawings to accommodate wall-mounted telephone sets. The wall plate shall be of stainless steel construction, accommodate one (1) voice jack as defined below, mount on a standard single gang outlet box or bracket and include mating lugs for wall phone mounting.
11. All Standard Information Outlets and the associated jacks shall be of the same manufacturer throughout the project. An allowable exception, however, is the wall-mounted "voice-only" outlet described above.

B. Data Jack
1. Data jacks shall be an 8-pin modular jack.
2. The interface between the jack and the station cable shall be a 110-style block or insulation displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
3. Data jacks shall be pinned per TIA-568A with pairs as follows:
   a) Pair 1 – Pins 5 & 4
   b) Pair 2 – Pins 3 & 6
   c) Pair 3 – Pins 1 & 2
   d) Pair 4 – Pins 7 & 8
4. Transmission characteristics of the data jack shall be as required to meet the TIA/EIA category 6 performance criteria. Refer to the Execution Section which details the required performance criteria of the completed link of which the jacks are a part.
5. The jack shall be UL verified and listed.
6. Jack contacts shall have a minimum of 50 micro-inches of gold plating.
7. The color of the Data Jack shall be Fog White.

C. Voice Jack
1. Voice jacks shall be non-keyed 8-pin Modular Jack (8P8C)
2. The interface between the jack and the station cable shall be a 110-style block or insulation displacement type contact. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
3. Voice jacks shall be pinned per T568A standard with the pairs as follows:
   a) Pair 1 – Pins 5 & 4
   b) Pair 2 – Pins 3 & 6
   c) Pair 3 – Pins 1 & 2
   d) Pair 4 – Pins 7 & 8
4. Voice termination hardware shall meet Category 6 performance specifications as defined by the referenced EIA/TIA documents.
5. The color of the voice jack shall be Fog White.

D. Wall-mount Voice-Only Outlets
1. Wall mounted "Voice Only" outlets shall be installed where identified ("W") on the Project Drawing(s) to accommodate wall-mounted telephone sets. The wall plate shall be of stainless steel construction, accommodate one (1) voice jack as previously defined, mounted on a standard single gang outlet or bracket and include mating lugs for wall phone mounting.

E. Fiber Optic Connector
1. The optical connector shall be SC-type.

2. The connector ferrule shall be ceramic or glass-in-ceramic, metallic, or equivalent. The optical fiber within the connector ferrule shall be secured with an adhesive or mechanical process to prevent pistoning and other movement of the fiber strand.
3. The connector body shall be of metal or a composite material.
4. The attenuation per mated pair shall not exceed the following values:
   a) Multimode 0.5-dB (individual); 0.3-dB (average)
   b) These values shall hold throughout the Cable system. Connectors shall sustain a minimum of 200 mating cycles per EIT/TIA-455-21 without violating specifications.
5. The connector shall meet the following performance criteria:

	Test Procedure	Max. Attenuation Change
a)	Test Procedure	Max. Attenuation Change
b)	Cable Retention (FOTP-6)	0.2-dB
c)	Durability (FOTP-21)	0.2-dB
d)	Impact (FOTP-2)	0.2-dB
e)	Thermal Shock (FOTP-3)	0.2-dB
f)	Humidity (FOTP-5)	0.2-dB

2.5 TELECOMMUNICATIONS CLOSET TERMINATIONS

A. Data Patch Panel

1. Data cabling shall be terminated at the main equipment room and telecommunications closets on patch panels incorporating modular jacks meeting the specifications for the telecommunications outlet detailed in the section above.
2. The patch panels shall be rack mounted.
3. The data patch panel shall consist of a Mini-Com Modules for UTP. Modular jacks shall meet the specifications detailed above (NON-KEYED 8-pin).
4. Patch panel shall be Panduit Mini-Com Angled Modular Faceplate patch panels.
5. The largest single patch panel configuration shall not exceed 48 ports. Panels that are modular shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12-jacks. No “High Density” data patch panels shall be allowed. (High Density is defined as those panels having less than one inch clearance between rows of modular connectors).
6. The patch panel blocks shall have the ability to seat and cut 8 conductors (4 pairs) at a time and shall have the ability of terminating 22-through 26-gauge plastic insulated, solid and stranded copper conductors. Data blocks shall be designed to maintain the cable’s pair twists as closely as possible to the point of mechanical termination.
7. The patch panel as a system (including jack, cable interface and intermediate components) must maintain category 6 performance per the referenced EIA/TIA documents. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.
8. Panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to insure that all manufacturers minimum bend radius specifications are adhered to.
9. The patch panel shall have color coded designation strips to identify cable count.
10. Transmission performance shall be maintained by the Data patch panel as a system (including jack, cable interface and intermediate components).

B. Voice Termination Field

1. At the telecommunications closets and main equipment room, each voice “backbone” cable and 4-pair “voice” station cable shall be terminated on high-density horizontal blocks.
2. Each horizontal row of the cross-connect block must be capable of terminating one (1) twenty-five pair binder group (Backbone Cables) or six (6) four pair groups (Station cables). Backbone and Station blocks shall be segregated clearly identifying their function.
3. The mechanical termination shall:
   a) have the ability of terminating 22-26 AWG plastic insulated, solid and stranded copper conductors.
   b) provide a direct connection between the cable and jumper wires.
   c) have less than 0.2-dB of attenuation from 1-16MHz.
   d) have less than 100mw of DC resistance.
   e) have less than 5 mw of resistance imbalance
   f) have minimal signal impairments at all frequencies up to16MHz

4. Blocks shall identify pair position by a color designation-Blue, Orange, Green, Brown, Slate (Backbone only).
5. The blocks shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
6. The voice termination hardware shall be 110-style.
   a) Voice station cabling termination
      1) Four (4) pair termination clips (e.g. C4) shall be used in the termination of voice station cabling.
   b) Voice backbone cabling termination
      1) Five (5) pair termination clips (e.g. C5) shall be used in the intermediate termination of voice backbone cabling.
7. Horizontal troughs incorporating plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block.
8. Vertical troughs incorporating metal distributing rings shall be provided in the Entrance Room for vertical routing of jumper and/or cross-connect wire. In each telecommunication closet, a backboard incorporating plastic distribution rings allowing for a change in direction in cross connect wiring shall be installed between the blocks on which station and backbone cabling are terminated.

2.6 FIBER OPTIC PATCH PANELS

A. All terminated fibers shall be mated to Duplex SC couplings mounted on enclosed patch panels. Couplers shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g. "FDDI Connector"), Bionic and FC by changing panels on which connector couplings are mounted.

B. At each TC these panels shall be rack mounted.

C. The patch panel enclosure shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings – including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the contractor, and/or those included in "Bid Alternates" (if applicable).

D. Patch panels shall be enclosed assemblies affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to protect the connector couplings and fiber optic jumpers.

E. The patch panel enclosures shall provide for strain relief of incoming cables and shall incorporate radius control mechanisms to limit bending of the fiber to the manufacturers recommended minimums or 1.2 inch, whichever is larger.

F. Access to the inside of the patch panel enclosure during installation shall be from front and/or rear. Panels that require any disassembly of the cabinet to gain entry will not be accepted.

G. All patch panels shall provide protection to both the "facilities" and "user" side of the coupling. The patch panel enclosure shall be configured to require front access only when patching. The incoming cables (e.g. Backbone, Riser, etc.) shall not be accessible from the patching area of the panel. The enclosure shall provide a physical barrier to access of such cables.

H. Where "Loose Buffered" cables are installed, the 250 µm coated fibers contained in these cables may be terminated wither by (1) splicing of factory-terminated cable assemblies ("pigtails") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering- an Aramid reinforced tube for example-with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and sub-assemblies are secured to prevent damage. Splicing shall be by the "Fusion" method. Individual splice loss shall not exceed 0.3dB for multi-mode fibers. Direct termination of 250 µm coated fibers shall not be permitted.

I. Where splicing of the cabling at system end points is a requirement of the installation, the Termination Enclosure shall incorporate a mechanism for securing the splice tray(s) and fiber slack. The splice tray and fiber slack shall not be accessible from the "user" side of the enclosure.

2.7 EQUIPMENT RACK

A. Free Standing Equipment Rack

1. At each telecommunications closet, equipment racks shall be furnished and installed by the contractor to house cable termination components (e.g. Copper data and fiber optic) and network electronics (by others). Refer to Part 3 ("Execution") of this section for quantities required at each location.
2. The rack shall conform to the following requirements
   a) Racks shall be 84 inches in height and shall be self-supporting.
   b) Channel uprights shall be spaced to accommodate industry standard 19 inch mounting.
   c) Rack must be constructed of aluminum and either have a coating or painted surface.
   d) Rack shall be double-sided, drilled and tapped to accept 12-24 screw. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per EIA/TIA specifications (5/8" – 5/8"-1/2"). Hole pattern on the rear shall be at 3 inch intervals to accept cable brackets.
   e) Rack should be supplied with a supply of spare screws (minimum of 24).
   f) Base footprint should be no smaller that 15 inches x 20 inches.
   g) Rack should be supplied with a ground bar and #6 AWG ground lug.

B. Jumper Management

1. Rack shall be equipped with vertical and horizontal jumper management hardware in the form of rings and guides, as to allow an orderly routing of twisted pair, optical fiber and coaxial jumpers from the patch panels to the customer provided network equipment. Jumper management hardware shall be as follows:
   a) Horizontal jumper management panels shall be painted steel 3.5 inch panel, have a minimum of five (5) jumper distribution rings. (1.75" x 3.75" minimum dimension) and incorporate jumper routing clips (plastic) for individual.
   b) At minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of jacks data patch panels, (b) each grouping of two rows of "F" connectors on coaxial patch panels and (c) above and below each fiber optic patch panel.
   c) Vertical jumper management shall provide for cable routing on front and rear of each rack and be 3 ½" square (minimum). Vertical jumper management hardware shall mount on spacers attached to the rack uprights and not on the upright itself. Where multiple racks are to be installed, this hardware shall be mounted between the uprights of adjacent racks. Rack uprights and the spacers shall be secured together per manufacturer recommendations.
   d) Each rack shall be supplied with a minimum of twelve (12) releasable (e.g. "hook and loop") cable support ties.
   e) Where cable termination hardware is wall mounted, the contractor shall be responsible for establishing a cable pathway for jumpers routed from the equipment rack(s) to the wall. This shall be in the form of slotted ducts, troughs or other means. Routing of jumpers via the overhead cable tray or ladder rack system is not acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Engineer prior to installation.

C. Equipment Cabinets (Wall Mount)

1. Where identified on the drawings, wall mounted equipment racks shall house all termination components installed under this contract.
   a) Be of a "two section" construction including (1) wall-mount section, and (2) drilled and tapped rail sections. Each section shall be hinged to facilitate access. Hinges shall be configurable to open LEFT OR RIGHT.
   b) Shall accommodate standard 19 inch mounting for patch panels and electronics.
   c) Hardware mounting depth (from front of channel upright to wall) shall be 12-inches.
   d) Shall have a load-bearing capacity of 100 lbs or greater.
2. The cabinets shall be constructed of painted steel or aluminum and offer a minimum usable mounting height of 12 RU (RU= 1 ¾ inch) and be a minimum of 12 inches deep. Access to the rear of the rack-mounted equipment shall be by a hinged arrangement.
3. The rack shall be spaced to accommodate industry standard 19-inch mounting and tapped to accept 12-24 screws.

4. Racks shall be equipped with vertical and horizontal cable management hardware, in the form of rigs and guides, as to allow an orderly routing of optical fiber and twisted pair jumpers from the patch panel to the customer provided network equipment. At a minimum, one such horizontal jumper management panel shall be provided with each cabinet. Jumper management panels shall be 3 ½ inch in height and have a minimum of five (5) jumper distribution rings.
5. Each rack shall be supplied with a minimum of twelve (12) releasable (e.g. "hook and loop") cable support ties and shall be supplied with a supply of spare screws (minimum of 24).

2.8 FLEXIBLE NONMETALLIC INNERDUCT AND FITTINGS

A. General
   1. Flexible non-metallic innerduct (e.g. "Innerduct") shall be used as follows:
      a) to segment conduit(s), increasing their capacity.
      b) as protection to backbone fiber optic cables when installed in cable tray, and
      c) as protection to fiber optic cables(s) within equipment rooms and telecommunications closets and the path between them.
   2. Innerduct shall be corrugated.
   3. Where not installed in a continuous length, innerduct segments should be spliced using couplings designed for that purpose.
   4. Any vacant innerduct shall be equipped with a pull cord and capped at all ends to inhibit the entry of water and comtaminants.
   5. Nominal duct size shall be 1-inch (minimum).
   6. Innerduct should be rated (e.g. General, Flame-retardant, Riser or Plenum) as required by the installation environment. Riser and Plenum innerduct shall be of a color contrasting to that of the "Standard" and Flame-retardant innerduct. The preferred colors are Orange ("Standard & Flame retardant) and White (Riser and Plenum).

B. Flame-retardant Innerduct
   1. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all of the above General requirements plus:
      a) Shall be fabricated of flame-retardant materials suitable for installation in such environments.
      b) Meet or exceed all requirements for flame propagation a specified by test method UL-2004 and referenced by the National Electrical Code NEC Sections 770 and 800 for listed optical fiber raceways being installed in plenum air spaces.

2.9 MISCELLANEOUS MATERIALS

A. Telecommunications Ground
   1. At each telecommunications closet, the main equipment room and at the electrical service entry, the Contractor shall install a "Telecommunications Grounding Busbar (TGB)".

B. Labels
   1. All labels shall be permanent and machine generated.

PART 3 EXECUTION

3.1 GENERAL

A. Contractor shall furnish and install all cables, connectors and equipment as shown on drawings and as specified above. It shall be noted that all cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

B. Refer to project drawings which indicate the termination location(s) within each building. Provide cable routing as required between termination points.

C. It is the contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified. This includes any modifications required to route and conceal horizontal distribution wiring

D. Beginning installation means contractor accepts existing conditions.

E. Contractor shall furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not limited tom sheaves, winches, cable reels, cable reel jackets, duct entrance tunnels, pulling tension gauge and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling had begun. Makeshift devices, which may move or wear in a manner to pose a hazard to the cable, shall not be used.

F. All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to insure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a “break - away” or other approved method.

G. The Contractor will be responsible for identifying and reporting to the site coordinator(s) any existing damage to walls, flooring, tiles and furnishings in the work area prior to start of work. All damage to interior spaces caused by the installation of cable, raceway or other hardware must be repaired by the Contractor. Repairs must match pre-existing color and finish of walls, floors, and ceilings. Any contractor-damaged ceiling tiles are to be replaced, at no cost to the Owner, to match color, size, style and texture.

H. Where unacceptable conditions are found, the Contractor shall bring this to the attention of the construction supervisor immediately. A written resolution will follow to determine the appropriate action to be taken.

I. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.

J. Cable pulling shall be done in accordance with cable manufacturer’s recommendations and ANSI/IEEE C2 standards. Manufacturer’s recommendations shall be a part of the cable submittal. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed. If any installed cable is kinked to a radius less than recommended dimension it shall be replaced by the Contractor with no additional cost to the project.

K. All wiring shall be run “free-air” above accessible ceilings, or in conduit raceway. All cable shall be free of tension at both ends.

L. Avoid abrasion and other damage to cables during installation.

M. Pulling lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.

N. The cable system will be tested and documented upon completion of the installation as defined in the section below.

O. A pull cord (nylon; 1/8 inch minimum) shall be co-installed with all cable in any conduit.

3.2 SYSTEM TOPOGRAPHY AND CABLE SIZE REQUIREMENTS

A. Backbone Cabling (Riser & Tie)

1. Backbone cables shall be installed to link telecommunications rooms as outlined on project drawings.

B. Voice Backbone Cabling

1. Backbone voice cabling shall be sized based on minimum pair counts (The pair counts shall include 30% growth to the nearest cable size). Cabling is to be terminated on 110-type blocks. The Contractor shall bond the outer metallic sheath of the cable to the TGB using a #6 AWG solid copper wire. This shall be as close as practical to the Building Entrance ground as defined by applicable code.

C. Fiber Optic Backbone

1. Fiber optic backbone cabling shall be sized based on fiber counts as outlined on project drawings. Cabling is to be terminated on patch panels.

D. Fiber Optic Cable Installation

1. Cable slack shall be provided in each Backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure. Slack required in the various subsystems is as follows:
   a) Backbone Intra-Building: A minimum of 5-meters (approx 15-feet) of slack (each cable if applicable) shall be coiled and secured at one (1) end – preferably at the Entrance Room and/or Main Equipment Room. Cable slack installed other than at each end of cable run shall not be allowed.
   b) Exact cable termination locations shall be field verified with Owner.
   c) Where exposed, all backbone fiber optic cable shall be installed in protective innerduct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g. between conduit and cable tray or into equipment rack(s). The innerduct should extend into the termination and/or storage enclosure(s) at system endpoints.

E. Station Cabling

1. Information outlet cables with copper media (voice and data UTP) shall be located as detailed on the project drawings.
2. The bidder in determining materials quantities and routing should utilize these documents.
3. Station cables shall run to the information outlet from the telecommunications closet serving each area in conduit and free-air above drop ceilings.
4. The maximum station cable drop length for data UTP shall not exceed 295-feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing station cabling in a fashion as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Engineer prior to installation. Changes to the plan shall be approved by the Engineer.
5. All cables shall be installed splice-free unless otherwise specified.
6. During pulling operation an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and to operate pulling machinery.
7. Avoid abrasion and other damage to cables during installation.
8. All cables shall be free of tension at both ends. In cases where the cable must bear some stress, Kellems grips may be used to spread the strain over a longer length of cable.
9. Where installed free-air, installation shall consider the following:
   a) Cable shall run at right angles and be kept clear of other trades work.
   b) Cables shall be supported according to code utilizing “J-Hook” mounting rings anchored to ceiling concrete, piping supports or structural steel beams. Hooks shall be designed to maintain cables bend to larger than the minimum bend radius (typically 2 x cable diameter).
   c) Supports shall be spaced at a maximum 4- foot interval unless limited by building construction. If cable “sag” at mid-span exceeds 6-inches, another support shall be used.
   d) Cable shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
   e) Cables shall not be attached to other cabling, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.
10. Manufacturers minimum bend radius specifications shall be observed in all instances.
11. Care should be taken in the use of cable ties to secure and anchor the station cabling. Ties should not be over tightened as to compress the cable jacket. No sharp burrs should remain where excess length of the cable tie has been cut.
12. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.

13. A coil of 4 feet in each cable shall be place in the ceiling at the last supports (e.g. J-Hook, Bridal Ring, etc.) before the cables enter a fishable wall, conduit, or box. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
14. To reduce or eliminate EMI, the following minimum separation distances from ≤480V power lines shall be adhered to:
    a) Twelve (12) inches from power lines of <5-kVa.
    b) Eighteen (18) inches from high voltage lighting (including fluorescent).
    c) Thirty-nine (39) inches from power lines of 5-kVa or greater.
    d) Thirty-nine (39) inches from transformers and motors.
15. All openings shall be sleeved and firestopped per prevailing code requirements upon completion of cable installation.

F. Station Cabling on Modular Furniture
1. Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via existing conduit.
2. Where modular furniture is installed without wall contact, the contractor shall install a recessed floor box. The selection of the recessed floor box shall consider fill ratios, bend limits on the Cat. 6 UTP and the eventual feed into the furniture partition.
3. Cabling shall be protected in the transition from the floor box or wall fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the floor box and wall fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill ratio (cable area vs. conduit area) in each feed shall not exceed 40%.
4. For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.
5. For purposes of bidding, it is to be assumed that it will be the responsibility of the contractor to punch and reinstall the bottom molding panels on the modular furniture as required to accommodate the communications cabling and SIOs. The panels shall be marked prior to installation by the Owner to identify the desired location of the SIOs. Any discrepancy between the project drawings identifying outlet locations and the markings should be brought to the attention of the Architect and Owner.
6. The SIO shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the SIO to the panel shall not result in sharp protrusions (e.g. sheet metal screw tip) into the channel behind the panel.

G. Information Outlets
1. Information Outlets shall be flush mounted in wall-mounted boxes.
2. Nominal height (from finished floor to center line of outlet) in new installation shall be as follows:
    a) Standard Voice & Data Outlet — 18 inches
    b) Wireless Access point (WAP) — 12 inches above finished ceiling
    c) Wall-Mounted Telephone Outlet — 54 inches
    d) Wall-Mounted Telephone Outlet for Wheelchair Persons:
        a) Approach head on — per ADA regulations
        b) Approach parallel — per ADA regulations

H. Innerduct
1. Innerduct shall be riser of plenum rated as required by the installation environment. At minimum, innerduct should extend to the ladder rack above the termination enclosure at system endpoints.
2. All exposed innerduct is to be labeled at 35-foot (minimum) intervals with tags indicating ownership, the cable type (e.g. "Fiber Optic Cable") and the cables it contains (e.g. MA-CS or FS-CS).
3. Where not installed in conduit, fiber optic cable shall be installed in protective innerduct.
4. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation insure that the mechanical limitations – including Minimum Bend Radius – of the cable are considered.
5. The innerduct should extend into the termination enclosure at system endpoints.

6. Where not installed in a continuous length, innderduct segments should be spliced using couplings designed for that purpose.
7. Should it be found by the Engineer, that the materials or any portion thereof, furnished and installed under this contract, fail to comply with the specifications and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

3.3 CABLE TERMINATION

A. General

1. At the telecommunications closets, all data cables shall be positioned on termination hardware in sequence of the outlet I.D. starting with the lowest number.
2. At the 110-block, all voice cables shall be positioned on termination hardware in sequence of the outlet I.D. starting with the lowest number.
3. Termination hardware (blocks and patch panels) positioning and layout must be reviewed and approved by the Engineer prior to construction. The review does not exempt the contractor from meeting any of the requirements stated in this document.

B. Cable Termination – Voice UTP

1. Voice pairs shall terminate on wall mounted 110 type blocks at the entrance room, main equipment room, and telecommunications closet. The Contractor shall coordinate the placement of blocks with the Engineer in order to integrate with other cabling.
2. Station blocks shall be provided to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation including change orders.
3. At information outlets and termination blocks, the installer shall insure that the twists in each cable pair are preserved to within 0.5 inch of the termination for voice cables. The cable jacket shall be removed only to the extent required to make the termination.
4. The Contractor shall furnish and install cable management hardware (e.g. D rings and cable guides) to neatly and securely route the cable from cable tray to the cable termination hardware.
5. The height of the voice termination field shall not exceed 6-feet (72-inches) above floor level to facilitate cable maintenance.
6. Blocks on which backbone and station cabling are terminated shall be positioned in separate columns. Backbone cabling should be positioned to the left; station cabling to the right and be in close proximity as to simplify installation and subsequent tracing of cross-connect wiring. Where new cabling is to be integrated with existing cabling at the building entrance, it will be the responsibility of the Contractor, in cooperation with the Owner, to coordinate placement of voice termination hardware the local exchange carrier(s) serving the site.
7. Cables shall be fed from below the termination hardware in a manner that will facilitate growth.
8. Horizontal troughs incorporating split plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of each column of termination blocks and between each 100-pair wiring block. Rings shall be positioned between the backbone and station blocks for vertical routing of jumpers and/or cross connect wiring,
9. Termination of horizontal voice (station) cabling shall be accomplished by using four-pair (e.g. C4-type) clips. The twenty-fifth pair of each row on the 110 type block located in the IDF shall not be used for termination of horizontal voice cable.
10. Termination of backbone voice cabling shall be accomplished by using five- pair (e.g. C5-type) clips.
11. The installer shall insure that the twists in each cable pair are preserved to within 1.0 inch of the termination for all UTP cables. The cable jacket shall be removed only to the extent required to make the termination

C. Cable Termination – Data UTP

1. Data patch panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.
2. Data patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation including change orders.

3. At information outlets and data patch panels, the installer shall insure that the twists in each cable pair are preserved to within 0.5 inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

D. Cable Termination – Fiber Optic
   1. ALL fibers shall be terminated using the specified connector type.
   2. Fibers shall be positioned consecutively and mapped “position for position” between patch panels. There shall be no transpositions in the cabling.
   3. Connectors from two cables shall never share a common coupling panel. Multi-mode and single mode optical fibers (where applicable) shall be segregated on the panels as to clearly identify the distinction between fiber types.
   4. All terminated fibers at the telecommunications closets shall be mated to couplings mounted on patch panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.
   5. All couplings shall be fitted with a dust cap.
   6. Fibers from multiple locations may share a common enclosure, however, they must be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure provided that they are clearly identified as such. Fibers from different locations shall not share a common connector panel (e.g. “insert”).
   7. Slack in each fiber shall be provided as to allow re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30 inch high workbench positioned adjacent to the termination enclosure(s). A minimum of 1-meter (~39 inches) of slack shall be retained regardless of panel position relative to the potential work area.
   8. Where “Loose Buffered” cables are installed, the 250µm coated fibers contained in these cables may be terminated either by 1) splicing of factory terminated cable assemblies (“pigtails”) or 2) use of a “fan-out” kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g. Kelvar) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and sub assemblies are secured to prevent damage. Splicing shall be by the “fusion” method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers and 0.1 dB for single mode fibers (of applicable). Direct termination of 250 um coated fibers shall not be permitted.

E. Voice Cross Connects
   1. This Contractor shall be responsible for the “Cross Connect” wiring between the station and backbone voice cabling.
   2. One (1) pair in each station cable shall be cross-connected to the backbone (riser or tie) cable . One pair Cross connect wire shall be used.
   3. Fastening cables directly to support brackets with wire or plastic ties will not be accepted. All cabling shall be neatly laced, dressed and supported. Retainer clips shall be used on each 110-type block to secure jumper wires on the wiring block(s).
   4. It shall be the responsibility of the Contractor to work with the Owner and site coordinator(s) and provide the necessary assistance to allow Owner and/or telephone company personnel to make the necessary connections to establish service on the new cable system. These activities include, but are not limited to cross connect documentation, general wiring overview and cable pair identification.

F. Equipment Rack (Free Standing)
   1. Equipment racks shall be furnished and installed by the Contractor as required to facilitate the system cable terminations.

G. Hardware.
   1. Data patch panel termination hardware shall be Panduit products to include:
      a) Patch panel Panduit #CPPLA48WBL, as required with 20% spare capacity.
      b) Horizontal pass thru Panduit #NCMHAEF4, (2) per rack.
      c) Vertical patch cable management Panduit #WMPVHC45E one each side (2) of rack containing 48 port angled patch panels.

2. Substitution of other brands must be approved by Owner before work begins. Contractor must supply Owner with substitution product catalog and product samples for approval.
3. Standard Information Outlet (SIO) hardware shall include both data and voice terminations and faceplate. Contractor must supply Owner with substitution product catalog and product samples for approval.

3.4 TESTING AND ACCEPTANCE

A. General

1. The Contractor is responsible to perform acceptance tests as indicated below for each sub-system (e.g. backbone, station, etc.) as it is completed.
2. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of the proposed test plan for each cable type including equipment to use used, set-up, test frequencies or wavelengths, results format, etc. The Engineer shall approve of the method of testing.
3. The Contractor shall visually inspect all cabling and termination points to insure that they are complete and conform to the wiring pattern defined herein. The contractor shall provide the Engineer with a written certification that this inspection has been made.
4. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner. Representatives of the Owner, may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week advance notice to the Engineer as to allow for such participation. The notification shall include a written description of the proposed conduct of the tests including copies of blank test result sheets to be used.
   a) IMPORTANT: Failure to provide the above information shall be grounds for the Owner/Engineer to reject any and all Documentation of Results on related testing and to require a repeat of the affected test.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only as required to prove the wiring connections are correct.
6. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Engineer, the Contractor shall provide copies of the original test results.
7. All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the contractor. The applicable tests shall then be repeated.
8. Should it be found by the Engineer that the materials or any portion thereof furnished and installed under this contract fail to comply with the specifications and drawings, with the respect or regard to the quality, amount of value of materials, appliances or labor used in the work, it shall be rejected and replaced by the Contractor and all work distributed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

B. Voice cabling (Copper UTP)

1. Backbone Cabling
   a) Backbone voice cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the termination blocks (e.g. 110). Any mispositioned pairs shall be identified and corrected. The percentage of "bad" pairs shall not exceed 3% in any Backbone (riser or tie) cable based on total pair count. All bad pairs must be identified and documented.
2. Station Cabling
   a) Testing shall be from the Jack at the SIO voice outlet to the termination block on which the cables are terminated at the TC or ER.
   b) All horizontal "Station" cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, wire map (conductor position on the modular jack). Any defective, split or mis-positioned pairs must be identified and corrected.
   c) Testing of the cabling systems rated at TIA category 6 shall be performed to confirm proper functioning and performance.
   d) In addition to the above, performance testing shall be performed on all cables. Testing of the transmission performance of station cables shall include the following:
      1) Length

2) Attenuation
3) PSNEXT Loss
4) Return Loss
5) PSELFEXT Loss
6) Propagation Delay
7) Delay Skew
8) Return loss

e) Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission performance testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify "PASS" on each cable and display the specified parameters – comparing test values with standards based "templates" integral to the unit.

f) Testing shall be per ANSI/TIA/EIA 568-B Permanent Link test; Category 6
1) Important: Where cross-connection of cabling sub-systems (e.g. Station and backbone) by the Contractor is specified, each subsystem shall be tested separately as defined above followed by a re-test of the interconnected system after cross connection is complete.

C. Data Station Cabling (Copper UTP)

1. Testing shall be from the jack at the SIO to the data patch panel on which the cables are terminated at the wiring hub.
2. Horizontal "station" cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and wire map (conductor position on the modular jack). Any defective, split or mis-positioned pairs must be identified and corrected.
3. Testing of the cabling systems rates at TIA category 6 shall be performed to confirm proper functioning and performance.
4. In addition to the above, performance testing shall be performed on all cables. Testing of the transmission performance of station cables (Category 6 and above) shall include the following:
   a) Length
   b) Attenuation
   c) PSNEXT Loss
   d) Return Loss
   e) PSELFEXT Loss
   f) Propagation Delay
   g) Delay Skew
   h) Return loss
5. Cables shall be tested to the maximum frequency defined by that standards covering that performance category. Transmission performance testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify "PASS" on each cable and display the specified parameters – comparing test values with standards based "templates" integral to the unit.
6. Testing shall be per ANSI/TIA/EIA 568-B Permanent Link test; Category 6.
7. The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables. Worst-case performance at 20 degrees C, based on a horizontal cable length of 90 meters and equipment cord length of 4 meters, shall be as follows:

Category 6 (PERMANENT LINK)

Frequency MHz	Attenuation Maximum dB	NEXT Loss Pair to pair (dB)	PS-NEXT Loss (dB; Worst Case)	ELFLEXT Loss pair to pair (dB)	PSEFLEXT Loss (dB)
1.0	2.1	60.0	58.6	55.6	57.0
4.0	3.9	54.8	51.8	46.5	43.5
8.0	5.5	50.5	47.0	40.5	37.5
10.0	6.2	48.5	45.5	38.6	35.6
16.0	7.9	45.2	42.2	34.5	31.5
20.0	8.9	43.7	40.7	32.6	29.6
25.0	10.0	42.1	39.1	30.6	27.6

31.25	11.2	40.5	37.6	28.7	25.7
62.5	16.2	35.7	32.7	22.7	19.7
100.0	21.1	32.3	29.3	18.6	15.6

D. Propagation Delay

1. The maximum propagation delay determined in accordance with TIA/EIA –568-B for a permanent link configuration shall be less than 518-ns measured at 10MHz. (Note: In determining the channel and permanent link propagation delay, the propagation delay contribution of connecting hardware is assumed to not exceed 2.5 ns from 1MHz to 100MHz.)

E. Delay Skew

1. The difference in propagation delay between the fastest and slowest pair in a cable shall not exceed the parameters below and the skew between all pair combinations shall not vary more than 610 ns when measured in accordance with TIA/EIA-568-B and ASTM 4566.
   a) Category 6 45ns between 1 MHz and 100MHz

F. Return Loss (permanent Link) Worst Pair

1. Frequency dB
   a) 1-20 MHz 19
   b) 20-100 MHz 19-7Log(f/20)
2. In order to establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an 8-position Category 6 Modular Plug (8-pin) to facilitate testing. Nominal velocity of propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP data is available from the cable manufacturer for the exact cable type under test.
3. In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacement and changes are necessary, and shall then repeat the test or tests which disclosed faulty or defective material, equipment or installation method, and shall make additional tests as the Engineer deems necessary at no additional expense to the project.

G. Fiber Optic Cable

1. General
   a) The fibers utilized in the installed cable be traceable to the manufacturer. Upon request by the Owner, the Contractor shall provide cable manufacturer's test report for each reel of cable provided. These test reports shall include (1) manufacturers on reel attenuation test results at the specified wavelengths for each optical fiber of each reel prior to shipment from the manufacture and (2) on-the-reel Bandwidth performance as tested at the factory.
2. Tests Prior to Installation
   a) The Contractor at their discretion and at no additional cost to the Owner – may perform tests deemed necessary by the Contractor to insure integrity of any Owner furnished optical fiber. Tests may range from a simple "flashlight test" to an OTDR of each optical fiber of each cable reel prior to installation. Upon request, the contractor shall supply this test data to the Engineer prior to installation.
3. Tests After Installation
   a) Upon completion of cable installation and termination, the Fiber Optic cabling shall be tested to include:
      1) Optical Attenuation ("Insertion Loss" Method)
4. Optical Attenuation Testing
   a) Optical Attenuation shall be measured on all terminated optical fibers in both directions of transmission using the "Insertion Loss" method. Measurement shall be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to insure that an accurate measurement of connector losses is made.
   b) Multi-mode fibers shall be tested in accordance with the EIA/TIA 526-14A, Method B at 850±30 nm. Single mode fibers (if applicable) shall be tested in accordance with the EIA/TIA 526-7-1998. Method A-1. Testing shall be at 1300±20 nm.
   c) Attenuation of optical fibers shall not exceed the values calculated at follows:
      1) Attenuation (max.) = 2 * C + L * F+ SdB

2) Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers) and F is the maximum allowable fiber loss (in dB/km). S is the total splice loss (# of splices * max. attenuation per splice).

d) RG – Testing
   1) All horizontal "Station" cables shall be free of shorts and opens and be verified for continuity. Any defective cables must be identified and corrected or replaced.
   2) DC resistance of the RG6 shall not exceed the values calculated as follows when tested using a 75 ohm terminator:
      a) Resistance (max.) = L * (R1 + R2) + 75 ohm
      b) Where L is the length of the run (in kilofeet) and R1 is the maximum allowable resistance of the center conductor (in ohm/kf) and R2 is the maximum allowable resistance of the shield (in ohm/kf).

3.5 DOCUMENTATION

A. General
   1. Upon Completion of the installation, the contractor shall provide three (3) full Documentation Sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.
   2. Documentation of Test Results shall be submitted in hard copy or in electronic form (preferred). Electronic documents may be submitted on CD-ROM (preferred) for review and distribution. Where documentation provided in electronic form requires unique software (other than a MS-Word™ compatible Word Processor or MS-Excel™ spreadsheet) for viewing test results, the Contractor shall provide along with the above documentation, one (1) licensed copy of such software. The software shall run on MICROSOFT *WINDOWS*-based personal computer supplied by the Owner.
   3. Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.) This is inclusive of all test result and *draft* as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.
   4. The Engineer may request that a 10% random filed re-test be conducted on the cable system – at no additional cost – to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

B. Test Data – Copper Media
   1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s)
   2. Printouts generated for each cable by the wire (or fiber) test instrument (e.g. *PentaScanner* or Optical Power Meter) shall be submitted as part of the documentation package. Alternately the contractor may furnish this information in electronic form (CD-ROM).

C. Test Data – Fiber Optic Media
   1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

D. Cross-Connect Data
   1. As noted above, it shall be the responsibility of the Contractor to work with the Owner and provide the necessary assistance to allow Owner and/or Telephone Company personnel to make the necessary connections to establish telephone service on the new cable system. These activities include, but are not limited to:
      a) A general wiring overview.
      b) Detailed cross connect documentation (relating SIO I.D. Room Number and Riser pair). The latter shall be in the form of an electronic format database (dBase, MS Excel or convertible format).

E. As-built Construction Drawings

1. Drawings include with the specification set shall be modified by the Contractor to denote as-built information.
2. The drawings are to include routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.
3. The Owner, thorough the Consultant, will provide floor plans in paper and electronic (".dwg", AutoCAD current release) formats on which as-built construction information can be added. These documents will be modified accordingly by the Contractor to denote as-built information as defined above and returned to the Consultant for acceptance. This information shall be supplied to the Consultant/Engineer no later than four (4) weeks prior to the scheduled occupancy of the building.
4. The Contractor shall annotate the base drawings and return to the A/E in hard copy (same plot size as originals) and electronic (AutoCAD current release) form.
5. Each drawing submitted by the Contractor as part of the Project Documentation shall be identified as an "As-Built" drawing and include the Contractor name and/or logo, and the date of the drawing.
6. All fonts, color, layer, model space/paper space conventions established in the base drawings shall be retained by the Contractor in preparation of the As-Built drawings.
7. Prior to generation of the drawings, the Contractor shall provide a sample file and test plot to the Engineer for review and approval.
8. All documentation, including hard copy and electronic forms shall become the property of the Owner,

F. Warranty

1. This Contractor shall guarantee all materials, equipment, etc, two (2) years from the date of substantial completion of this work. This guarantee shall include all labor, material and travel time. See Division 01, General Requirements for further requirements.

END OF SECTION

SECTION 271100
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Telecommunications mounting elements.
   2. Backboards.
   3. Telecommunications equipment racks and cabinets.
   4. Grounding.

B. Related Requirements:
   1. Section 27 05 26 “Grounding and Bonding for Communications Systems”
   2. Section 27 05 28.33 “Conduit and Back Boxes for Communications”
   3. Section 27 10 00 "Structured Cabling" for voice and data cabling associated with system panels and devices.
   4. Section 28 05 13 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

1.3 SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Qualification Data: For installer, qualified layout technician, installation supervisor, and field inspector.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD**.**
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 PRODUCTS

2.1 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).

2.2 EQUIPMENT FRAMES

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

1. Belden Inc
2. Cooper B-Line.
3. Hubbell Premise Wiring.
4. Leviton Commercial Networks Division.
5. Panduit Corp.
6. Siemon Co. (The).
7. Tyco Electronics Corporation; AMP Products.

B. General Frame Requirements:
1. Modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Hinged and lockable doors.
5. Screened ventilation openings.
6. Cable access provisions.
7. Grounding bus bar.
8. Rack-mounted, 550-cfm fan with filter.
9. Power strip.
10. All cabinets keyed alike.

C. Cable Management:
1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 POWER STRIPS

A. Power Strips: Comply with UL 1363.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Six, 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Cord connected with 15-foot (4.5-m) line cord.
8. Rocker-type on-off switch, illuminated when in on position.
9. Peak Single-Impulse Surge Current Rating: 13 kA per phase.
10. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.4 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:
1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with J-STD-607-A.

2.5 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and housing when so directed by service provider.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 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 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section " Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
   1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A.

D. Labels shall be preprinted or computer-printed type.

END OF SECTION

SECTION 280513
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. UTP cabling.
2. 50/125-micrometer, multimode optical fiber cabling.
3. RS-232 cabling.
4. RS-485 cabling.
5. Low-voltage control cabling.
6. Control-circuit conductors.
7. Fire alarm wire and cable.
8. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

F. RCDD: Registered Communications Distribution Designer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight.
2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

1.7 FIELD CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

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

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.
2. AMP Netconnect; a brand of Tyco Electronics Corporation.
3. Belden Inc.
4. Berk-Tek; a Nexans company.
5. CommScope, Inc.
6. Draka Cableteq USA.
7. Genesis Cable Products; Honeywell International, Inc.
8. Mohawk; a division of Belden Networking, Inc.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope, Inc. brand.
11. 3M; Communication Markets Division.

B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a) Communications, General Purpose: Type CM or CMG.
b) Communications, Riser Rated: Type CMR, complying with UL 1666.
c) Communications, Limited Purpose: Type CMX.
d) Multipurpose: Type MP or MPG.
e) Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.3 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. AMP Netconnect; a brand of Tyco Electronics Corporation.
4. Belden Inc.
5. Dynacom Inc.
6. Hubbell Incorporated; Hubbell Premise Wiring.
7. Leviton Commercial Networks Division.
8. Molex Premise Networks; a division of Molex, Inc.
9. Panduit Corp.
10. Siemon.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110-style for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.4 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AMP Netconnect; a brand of Tyco Electronics Corporation.
2. Belden Inc.
3. Berk-Tek; a Nexans company.
4. CommScope, Inc.
5. Corning Incorporated; Corning Cable Systems.
6. CSI Technologies Inc.
7. General Cable Technologies Corporation.
8. Mohawk; a division of Belden Networking, Inc.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope, Inc. brand.
11. 3M; Communication Markets Division.

B. Description: Multimode, 50/125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA-492AAAB for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a) General Purpose, Nonconductive: Type OFN or OFNG.
    b) Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
    c) General Purpose, Conductive: Type OFC or OFCG.
    d) Riser Rated, Conductive: Type OFCR, complying with UL 1666.

5. Conductive cable shall be steel armored type.
6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Aqua for 50/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.5 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Berk-Tek; a Nexans company.
5. Corning Incorporated; Corning Cable Systems.
6. CSI Technologies Inc.
7. Dynacom Inc.
8. Hubbell Incorporated; Hubbell Premise Wiring.
9. Molex Premise Networks; a division of Molex, Inc.
10. Siemon.

B. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

1. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.6 RS-232 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with UL 1581.

2.7 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

2.8 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

2.9 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.

B. Class 2 Control Circuits: Stranded copper, **T**ype THHN-THWN, complying with UL 83, in raceway.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.10 FIRE ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Comtran Corporation.
2. Draka Cableteq USA.
3. Genesis Cable Products; Honeywell International, Inc.
4. Rockbestos-Suprenant Cable Corp.
5. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.11 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Worldwide, Inc.
2. HellermannTyton North America.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

2.12 SOURCE QUALITY CONTROL

A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD

A. Install wiring in metal pathways and wireways.

1. Minimum conduit size shall be 3/4 inch (21 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.
2. Comply with requirements in Section 280528 "Pathways for Electronic Safety and Security."

B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
4. Install conductors parallel with or at right angles to sides and back of enclosure.
5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
6. Mark each terminal according to system's wiring diagrams.
7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. 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.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 6 rating of components and that ensure Category 6 performance of completed and linked signal paths, end to end.

1. Comply with TIA/EIA-568-B.2.
2. Install 110-style IDC termination hardware unless otherwise indicated.

3. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

E. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

F. 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 60 inches (1525 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
b) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
c) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
b) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a) Electrical Equipment Rating Less Than 2 kVA: No requirement.
b) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
c) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.6 CONNECTIONS

A. Comply with requirements in Section 28 31 11 "Digital, Addressable Fire-Alarm System for connecting, terminating, and identifying wires and cables.

3.7 FIRESTOPPING

A. Comply with requirements in Section 07 84 00 Firestopping."

B. Comply with TIA-569-B, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.8 GROUNDING

A. For communications wiring, comply with J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.9 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.10 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:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.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 DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.

    a) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.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.

4. Optical Fiber Cable Tests:

    a) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b) Link End-to-End Attenuation Tests:

        1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

C. 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.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 28 05 28
PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetallic conduits, tubing, and fittings.
   3. Optical-fiber-cable pathways and fittings.
   4. Metal wireways and auxiliary gutters.
   5. Boxes, enclosures, and cabinets.
   6. Handholes and boxes for exterior underground cabling.

B. Related Requirements:
   1. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
   2. Section 26 05 33 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
   3. Section 27 05 28.33 "Conduits and Back Boxes for Communications" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving communications systems.

1.2 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.3 ACTION SUBMITTALS

A. Product Data: For surface pathways, 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.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of pathway groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Allied Tube & Conduit; a Tyco International Ltd. Co.
   3. Alpha Wire Company.
   4. Anamet Electrical, Inc.
   5. Electri-Flex Company.
   6. O-Z/Gedney; a brand of EGS Electrical Group.
   7. Picoma Industries; Subsidiary of Mueller Water Products, Inc.
   8. Republic Conduit.
   9. Robroy Industries
   10. Southwire Company.
   11. Thomas & Betts Corporation.
   12. Western Tube and Conduit Corporation.
   13. Wheatland Tube Company; a division of John Maneely Company.

B. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. FMC: Comply with UL 1; zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Fittings for EMT.
      a) Material: Steel.
      b) Type: Setscrew or compression.
   2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 467, rated for environmental conditions where installed, and including flexible external bonding jumper.

I. Joint Compound for IMC and GRC: 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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Allied Tube & Conduit; a Tyco International Ltd. Co.
   3. Anamet Electrical, Inc.
   4. Arnco Corporation.
   5. CANTEX Inc.
   6. CertainTeed Corp.
   7. Condux International, Inc.
   8. Electri-Flex Company.
   9. Kraloy.
   10. Lamson & Sessions; Carlon Electrical Products.
   11. Niedax-Kleinhuis USA, Inc.

12. RACO; a Hubbell Company.
13. Thomas & Betts Corporation.

B. General Requirements for Nonmetallic Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. LFNC: Comply with UL 1660.

E. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: Comply with UL 514B.

G. 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).

H. 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 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Alpha Wire Company.
   2. Arnco Corporation.
   3. Endot Industries Inc.
   4. IPEX.
   5. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible-type pathway, approved for general-use installation unless otherwise indicated.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper B-Line, Inc.
   2. Hoffman; a Pentair company.
   3. Mono-Systems, Inc.
   4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 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.
   2. Comply with TIA-569-B.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. Hoffman; a Pentair company.
6. Hubbell Incorporated; Killark Division.
7. Lamson & Sessions; Carlon Electrical Products.
8. Milbank Manufacturing Co.
9. Molex, Woodhead Brand
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Device Box Dimensions: 4-inches square by 2-1/8 inches deep (100 mm square by 60 mm deep). **(100 mm by 60 mm by 60 mm deep)**

I. Gangable boxes are not allowed.

J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:

    a) Material: Plastic.
    b) Finished inside with radio-frequency-resistant paint.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1, 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.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

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.
   3. Comply with TIA-569-B.

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

      a) Armorcast Products Company.
      b) Carson Industries LLC.
      c) NewBasis.
      d) Oldcastle Precast, Inc.; Christy Concrete Products.
      e) Quazite; Hubbell Power Systems
      f) Synertech Moulded Products; a division of Oldcastle Precast, Inc.
   2. Standard: Comply with SCTE 77.
   3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, "SIGNAL" or “COMMUNICATIONS."
   7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: GRC.
   3. Underground Conduit: RNC, Type EPC-40-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 4X.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   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. Pathways for Concealed General Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
   8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4X stainless steel in damp or wet locations.

C. Minimum Pathway Size: (16-mm)3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
   3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum boxes, or fittings in contact with concrete or earth.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Pathways 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 pathways to reinforcement at maximum 10-foot (3-m) intervals.
   2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange pathways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete.
   5. Change from RNC, Type EPC-40-PVC to GRC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT or RMC for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

O. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

P. Install pull wires in all pathways in addition to the conductors and cables being installed. 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 pathways designated as spare above grade alongside pathways in use.

Q. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

R. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

S. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

T. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

U. Expansion-Joint Fittings:

1. Install in each run of aboveground EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 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.
3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
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.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use maximum of 24 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. 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.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set floor boxes level and 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 Section 31 20 00 "Earth Moving."
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
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 Section 31 20 00 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout the 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 26 05 53 "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 ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 00 " 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 paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 280544
SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY PATHWAYS AND CABLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathway 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 84 00 " 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. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

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

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

F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
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 pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel 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, provide products by 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.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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 pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "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 pathway 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.

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 pathways 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 pathway 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 pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway 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

SECTION 283111
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Remote annunciator.
7. Addressable interface device.
8. Digital alarm communicator transmitter.

1.2 DEFINITIONS

A. FACP: Fire Alarm Control Panel.

B. LED: Light-emitting diode.

C. NFPA: National Fire Protection Association.

D. NICET: National Institute for Certification in Engineering Technologies.

1.3 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

1.4 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: For fire-alarm system. Include plans, riser diagrams, wiring diagrams, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:

a) Trained and certified by manufacturer in fire-alarm system design.
b) NICET-certified fire-alarm technician, Level III minimum.
c) Licensed or certified by authorities having jurisdiction.

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

1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.7 FIRE ALARM PLAN REVIEW SUBMITTALS

A. The Contractor and fire alarm system supplier shall prepare necessary sets of plans and forms of the fire alarm system for approval by the Wisconsin Department of Safety and Professional Services, Industry Services Division (DSPS) and the local Authority Having Jurisdiction (AHJ) prior to construction. Submittal requirements shall include:

1. Battery calculations.
2. Voltage drop calculations for all circuit runs.
3. Device information including coverage area of detectors, visual and audio ratings, etc.
4. Locations of all devices. Additional devices as needed to meet all code requirements shall be included in bid to meet all applicable codes (additional devices beyond those shown on the plans that are identified by the Engineer during shop drawing review and/or as determined by the AHJ/DSPS approval process will not be paid as a change order).
5. Complete list of detection, evacuation signaling and annunciator zones and/or addresses.
6. Complete sequence of operations, detailing all inputs and outputs.
7. Complete list of fire control function (i.e. fan shut down, etc.).
8. All other information required for review and approval.
9. Floor plans.

B. Plans and forms shall be stamped and signed by the Contractor’s engineer prior to submittal.

C. The Contractor and/or fire alarm supplier shall submit all stamped plans and forms, and include payment for the plan review fee to the appropriate authorities.

D. The Contractor shall apply for the permit from the appropriate AHJ and include all work related and necessary in the bid.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 "Operation and Maintenance Data," deliver copies to authorities having jurisdiction and include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

a) Frequency of testing of installed components.
b) Frequency of inspection of installed components.
c) Requirements and recommendations related to results of maintenance.
d) Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.9 MAINTENANCE MATERIAL SUBMITTALS

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

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 5 units.
3. Pull Stations: Quantity equal to 10 percent of amount installed, but no fewer than 2 units.
4. Smoke Detectors and heat detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 5 units of each type.
5. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
6. Keys and Tools: One extra set for access to locked and tamper proofed components.
7. Audible and Visual Notification Appliances: Five of each type installed.
8. Fuses: Two of each type installed in the system.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.

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

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.11 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Edwards Systems Technology, Inc.
2. Fire Control Instruments, Inc.; a Honeywell company.
3. GAMEWELL; a Honeywell company.
4. GE Infrastructure; a unit of General Electric Company.
5. NOTIFIER; a Honeywell company.
6. Siemens Building Technologies, Inc.; Fire Safety Division.
7. SimplexGrinnell LP; a Tyco International company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciator.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Activate audible and visual alarm notification appliances.
5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
6. Record events in the system memory.

C. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

D. System Trouble Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciator. Record the event in the system memory.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a) System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
    b) Include a real-time clock for time annotation of events on the event recorder.

2. Addressable initiation devices that communicate device identity and status.

    a) Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.

b) Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 2 line(s) of 40 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.

a) Initiating Device Circuits: Style B.
b) Notification Appliance Circuits: Style Y.
c) Signaling Line Circuits: Style 4.
d) Install no more than 50 addressable devices on each signaling line circuit.

2. Serial Interfaces: Two RS-232 ports for printers.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events in the system memory.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Notification Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41 60 beats per minute, march-time pattern and be synchronized when required.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

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

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key-operated switch.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a) Primary status.
b) Device type.
c) Present average value.
d) Present sensitivity selected.
e) Sensor range (normal, dirty, etc.).

2.6 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on the faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens or on the faceplate adjacent to the lens.

1. Rated Light Output:

a) 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. Flashing shall be in a temporal pattern, synchronized with other units.
4. Strobe Leads: Factory connected to screw terminals.
5. Mounting Faceplate: Factory finished, red.

2.8 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.

3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the trouble-initiating device.
3. Loss of ac supply or loss of power.
4. Low battery.
5. Abnormal test signal.
6. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

C. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet (1 m)(1.5 m) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

D. Remote Status and Alarm Indicators: Install near each smoke detector that is not readily visible from normal viewing position.

E. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

F. Visible Alarm-Indicating Devices: Install not less than 80” or more than 96” above the finished floor, and not less than 6 inches (150 mm) below the ceiling.

G. Device Location-Indicating Lights: Locate in public space near the device they monitor.

H. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

I. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.2 IDENTIFICATION

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

B. Install framed instructions in a location visible from fire-alarm control unit.

3.3 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.4 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a) Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
    b) Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 310200
GENERAL REQUIREMENTS FOR SITEWORK

PART 1 GENERAL

1.1 SUMMARY

A. This Section governs only technical specifications related to site work construction.

B. Section Includes:

1. Definitions.
2. Field Engineering.
3. Pre-installation Meeting.
4. Demonstration and Training Meeting.
5. Submittal Procedures.
6. Traffic Control Plan.
7. Quality Control Requirements.
8. Erosion and Sediment Control.
9. Proposed Products List.
10. Product Requirements.
11. Project Closeout Procedures.

C. Related Sections:

1. Division 02 – Existing Conditions.
2. Division 31 – Earthwork.
3. Division 32 – Exterior Improvements.
4. Division 33 – Utilities.

1.2 DEFINITIONS

A. Field Engineering: Contractor's establishment of elevations, lines, and levels as indicated on Drawings, utilizing recognized engineering survey practices.

B. Pre-installation Meeting: Meeting to discuss a product or material, typically complex in nature, and review manufacturer's precautions, restrictions, and installation procedures.

C. Demonstration and Training Meeting: Contractor and/or manufacturer representative administered demonstration and training sessions for Owner for each portion of equipment and products that are required to have training in proper operation and maintenance.

D. Submittal Procedures: Specified requirements regarding procedures related to submission of product data, Shop Drawings, manufacturer's certificates, and substitutions.

E. Traffic Control Plan: Plan developed consistent with Manual on Uniform Traffic Control Devices (MUTCD).

F. Quality Control: Inspection, analysis, and other relevant actions taken to provide control over what is being done, manufactured, or fabricated, so that a desirable level of quality is achieved and maintained during duration of the Work.

G. Erosion and Sediment Control: Enforcement of state law and city or county ordinance for erosion and sediment control including installation, maintenance, and regular Contractor inspection and repair.

H. Proposed Product List: Prepared listing of all materials and products intended to be used for site work related to sewer and water utilities, aggregates, and soils, and pavement mix designs.

I. Product Requirements: Product information regarding manufacturer's data, preparation, fabrication, conveying and erection of Work including material, machinery, components, equipment, fixtures, and systems incorporated in Work.

J. Project Closeout Procedures: Process that provides acceptance of project by Owner and Engineer including verification and documentation of required project records, and retention of other essential project documentation.

1.3 FIELD ENGINEERING

A. Employ Land Surveyor registered in State of Wisconsin and acceptable to Engineer.

B. Contractor shall locate and protect survey control and reference points. Promptly notify Engineer of discrepancies discovered.

C. Control datum for survey is that shown on Drawings.

D. Verify setbacks and easements; confirm drawing dimensions and elevations.

E. Provide required field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

F. Submit copy of site drawing and certificate signed by registered Land Surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.

G. Maintain complete and accurate log of control and survey work as Work progresses.

H. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

I. Promptly report to Engineer loss or destruction of reference point or relocation required because of changes in grades or other reasons.

J. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.

K. A Registered Land Surveyor shall replace damaged property corners at Contractor's expense.

1.4 PREINSTALLATION MEETING

A. When required in individual specification sections, convene preinstallation meeting at Project site prior to commencing work of specific section.

B. Require attendance of parties directly affecting, or affected by, Work of specific section.

C. Notify Owner, Engineer, and Architect seven (7) days in advance of meeting date.

D. Prepare agenda and preside at meeting:

1. Review conditions of installation, preparation and installation procedures.
2. Review coordination with related work.

E. Record minutes and distribute copies within two (2) days after meeting to participants, with two (2) copies to Owner, Engineer, and Architect and those affected by decisions made.

1.5 DEMONSTRATION AND TRAINING MEETING

A. Contractor shall schedule and administer demonstration and training sessions for Owner for each portion of equipment and products that are required to have training in proper operation and maintenance.

B. Contractor shall schedule representatives of equipment manufacturer to attend demonstration and training sessions to provide additional information as necessary.

1.6 SUBMITTAL PROCEDURES

A. Contractor shall provide Engineer electronic PDF copies of specific submittal information regarding products and materials of this specification section with extended permission of Architect.

B. Submit Shop Drawings and product data in electronic PDF copies covering identified equipment and materials that will become a permanent part of Work to Engineer for review.

C. Electronically submit material information, product data, and shop drawings in PDF format directly to Engineer.

D. Shop Drawings and product data shall include drawings, descriptive information, and sufficient detail to show kind, size, arrangement, and operation of component materials and devices needed for installation and coordination with other materials and equipment.

E. All submittals, regardless of origin, shall be stamped with approval of Contractor and identified with name of the Project, Contractor's name, and references to applicable specification sections and Drawings.

F. Each submittal shall indicate intended use of item in Work. When manufacturer data sheets are submitted, clearly identify applicable items and cross out inapplicable data.

G. Manufacturer's data sheets shall be current and include issue number and date.

H. Contractor's stamp of approval is a representation to Engineer that Contractor accepts full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, and that Contractor reviewed and coordinated each submittal with requirements of the Work.

I. Contractor shall accept full responsibility for completeness of each submission. When an item consists of components from several sources, Contractor shall submit a complete initial submittal including all components.

J. Identify deviations from Specifications and Drawings on each submittal and tabulate in Contractor's letter of transmittal. Such submittals shall indicate details of proposed changes, including modifications to other facilities that may result from deviation, and required piping and wiring diagrams.

K. Submit electronic PDF copies of each drawing and necessary data to Engineer.

L. Engineer will not accept submittals from anyone but Contractor or Architect.

M. Submittals shall be consecutively numbered in direct sequence of submittal and without division by subcontracts or trades.

N. Review of Shop Drawings and Product Data:
   1. Engineer's review of Shop Drawings and product data will cover only general conformity to Drawings and Specifications, external connections, and dimensions that affect layout. Engineer's review does not indicate a thorough review of all dimensions, quantities, and details of material, equipment, device, or item shown.
   2. Engineer's review shall not relieve Contractor of Contractor's responsibility for errors, omissions, or deviations in drawings and data, or of sole responsibility for compliance with the Work.
   3. Engineer's submittal review period shall be a maximum of seven (7) days from date of submittal or resubmittal.
   4. When Shop Drawings and data are returned marked "NOT ACCEPTABLE" or "RETURNED FOR CORRECTION", Contractor shall make corrections as noted by Engineer and resubmit.
   5. When Shop Drawings and product data are returned marked "EXCEPTIONS NOTED" or "APPROVED AS SUBMITTED", no additional copies need be submitted unless requested by Engineer at time of review.

O. Re-submittal of Shop Drawings and Product Data:
   1. Contractor shall accept full responsibility for completeness of each re-submittal.
   2. Contractor shall verify that resubmittal provides all corrected data and additional information previously requested by Engineer.
   3. When corrected files are re-submitted, Contractor shall indicate in writing revisions made.
   4. Requirements specified for initial submittals also apply to re-submittals.
   5. Re-submittals shall bear number of first submittal followed by a letter (A, B, etc.) to indicate sequence of re-submittal.
   6. Make re-submittals within seven (7) days of date of letter returning material to be modified or corrected.

P. Substitutes and "Or-Equal" Items:

1. Whenever a material or article is specified or described by using a single name of a proprietary product or a single name of a particular manufacturer or vendor, specified item mentioned shall be understood as establishing type, function, and quality desired.
2. Whenever two or more names of proprietary products or particular manufacturers or vendors are used, it shall be understood that products of one named supplier shall be furnished with no options or substitutions allowed.
3. Products, materials, or equipment not specified by proprietary name and submitted as a proposed substitute shall be reviewed and approved or rejected by Engineer.
4. Cost of proposed substitution review is subject to financial reimbursement from Contractor to Engineer for time taken for review and verification in the amount of $200.00 dollars for each hour of review and verification.
5. Contractor shall be liable for all costs incurred by Engineer related to each substitution review, including proposed substitutions which are rejected.

1.7 TRAFFIC MANAGEMENT PLAN

A. Submit a traffic management plan for construction in accordance with the "Manual on Uniform Traffic Control Devices."

B. Traffic management plan must clearly depict exact sequence of construction operation(s), construction to be performed, and traveled way that will be utilized by all movements of traffic during each phase of construction.

C. Multiple phases of construction will require a separate traffic management plan for each different construction phase or operation.

1.8 QUALITY CONTROL REQUIREMENTS

A. Construction Notification:
   1. Contractor shall be responsible for locating existing underground installations in advance of excavating or trenching by contacting local utility identification agency.

B. Licenses, Permits, and Certificates:
   1. All licenses, permits, and certificates, required for, and in connection with site and utility work shall be secured by Contractor at their sole cost and expense.
   2. Contractor will be required to pay any permit fees for required for utility work.
   3. Contractor shall comply with all requirements and recommendations of authority or authorities issuing license, permit, or certificate.

C. Easements and Rights-Of-Way:
   1. Contractor will confine construction operations to areas designated on Drawings or identified by Engineer.
   2. Contractor shall use care in placement of construction tools, equipment, excavated materials, pipe materials, and supplies so as to minimize damage to property and minimize interference with the public.

D. Protection of Property:
   1. Contractor shall protect from damage or injury all property including survey monuments, property markers, and benchmarks. Items damaged shall be replaced or repaired at Contractor's expense.
   2. Locate existing utilities and utility services in advance of excavation and protect against damage. Changes in grade and alignment may be made to Work to avoid conflicts with existing structures if approved by Engineer.

E. Reference Standards:
   1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to laws or regulations of any governmental authority, whether such reference be specific or by implication, shall mean latest edition of appropriate standard, specification, manual, code, law, or regulation in effect on date of first advertisement for the Work, unless specifically stated otherwise in Contract Documents.
   2. Should there be a conflict in Reference Standards, Contractor shall request clarification from Engineer before proceeding.

F. Compaction and Gradation Testing:
   1. Contractor shall provide and pay for compaction and gradation testing by an approved independent testing laboratory.
      a. Make two (2) initial gradation tests for each type of bedding and backfill material, and make one additional gradation test for each additional 500 tons of each material.
      b. Moisture-density (Proctor) tests and relative density tests on materials, and in-place field density tests, shall be made at intervals determined by Testing Agency.
      c. Perform compaction and proof roll testing in accordance with procedures specified in Section 312317 – Site Excavation, Backfill, and Compaction and Section 321123 – Aggregate Base Course.

G. Traffic Control - General:
   1. Protect streets, roads, highways, pathways, and other public thoroughfares that are to be temporarily closed or restricted for traffic flow by effective barricades equipped with operational warning signals.
   2. Cover open trenches and other excavations with steel plates and have suitable barricades, signs, and lights to provide adequate protection to the public. Provide obstructions such as material piles and equipment with similar warning signs and lights.

H. Maintenance of Traffic:
   1. Maintain effected traffic areas throughout duration of construction, in accordance with local, state, or federal requirements which govern Work area.
   2. Contractor is responsible for maintaining traffic.
   3. Contractor shall conduct work to minimize interference with traffic, vehicular or pedestrian.
   4. Contractor shall provide and maintain suitable detours or other temporary measures for accommodating public and private travel.
   5. Illuminate barricades and obstructions with warning lights from sunset to sunrise.
   6. Store material and perform Work to minimize obstruction and inconvenience to public.

I. Traffic Control Devices:
   1. Contractor shall provide barricades, cones, construction warning signs, flagmen, and incidental devices to protect personnel and equipment on the Work site.

1.9 EROSION AND SEDIMENT CONTROL

A. Comply with requirements specified in Section 312513 – Erosion and Sediment Controls and as indicated on Drawings.

1.10 PROPOSED PRODUCTS LIST

A. Within seven (7) days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.11 PRODUCT REQUIREMENTS

A. Products include material, equipment, and systems.

B. Comply with specifications and referenced standards as minimum requirements.

C. Components required to be supplied in quantity within a Specification section shall be same, and shall be interchangeable.

D. Do not use materials and equipment removed from existing structure, except as specifically required or allowed by Contract Documents.

E. Products Specified by Reference Standards or by Description Only: Furnish any product meeting those standards.

F. Products Specified by Naming One (1) or More Manufacturers or with a Provision for Substitutions: Submit a request for substitution of a proposed equal.

1.12 PROJECT CLOSEOUT PROCEDURES

A. Project Records Documents:
   1. Contractor shall maintain, on site, one (1) set of the following record documents:
      a. Drawings.
      b. Specifications.
      c. Approved Shop Drawings.
      d. Product data.
      e. Samples.
   2. Contractor shall store Record Documents separate from documents used for construction.
   3. Contractor shall record actual revisions to the Work and maintain information concurrent with construction progress.
   4. Contractor shall legibly mark each item to record actual construction including:
      a. Measured horizontal and vertical locations of new utilities and existing underground utilities and appurtenances referenced to permanent surface improvements.
      b. Field changes of dimensions and Drawing details.
      c. Details not on original Drawings.
   5. Submit Record Documents to Engineer and Owner at Final Inspection, including:
      a. Project Drawings.
      b. Survey notes.
      c. Approved submittals.
      d. Operation and Maintenance Manuals.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 310513
SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Subsoil materials.
   2. Topsoil materials.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 024113 – Site Demolition.
   3. Section 024114 - Utility Abandonment and Removal.
   4. Section 310516 – Aggregates for Earthwork.
   5. Section 312213 - Rough Grading.
   6. Section 312317 – Site Excavation, Backfill, and Compaction.
   7. Section 312513 – Erosion and Sediment Controls: Erosion and sediment control requirements.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
   1. Standard Specifications for Highway and Structure Construction, Current Edition.
   2. http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

B. ASTM International (ASTM):
   1. ASTM D2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   2. ASTM D5268 – Topsoil Used for Landscaping Purposes.

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Samples: Submit, in airtight containers, 10 lb. sample of each type of fill to testing laboratory.

C. Product Data: Submit testing laboratory results for each type of specified soil.

D. Materials Source: Submit name of source of imported materials.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation standards.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1:
   1. Excavated and re-used material.
   2. Graded.
   3. Free of lumps larger than three (3) inches, rocks larger than two (2) inches, organic matter, and debris.
   4. Contractor shall provide 10 lb sample of existing site material to laboratory for soil classification analysis conforming to ASTM D2487.

B. Subsoil Type S2:
   1. Imported borrow.
   2. Graded.
   3. Free of lumps larger than three (3) inches, rocks larger than two (2) inches, organic matter, and debris.
   4. Imported subsoil and borrow shall be similar in composition when compared to existing site subsoil.
   5. Contractor shall provide 10 lb sample of proposed imported borrow material to laboratory for soil classification analysis conforming to ASTM D2487.

C. Subsoil Type S3:
   1. Shall be used at depths of 1.5 to 3.0 feet below finished grade at locations shown on plans.
   2. Will be covered by 1.5 feet of Topsoil Type T3.
   3. May be excavated and reused material or imported borrow.
   4. Graded and screened to be free of lumps larger than 2-inches diameter.
   5. Free of rocks larger than 1-inch diameter; and organic matter, including organic soils, roots and tree material, and vegetation.
   6. Free of debris and foreign objects.
   7. Contractor shall provide 10 lb sample for each 500 cubic yards delivered or processed for laboratory classification analysis conforming to ASTM D2487.

2.2 TOPSOIL MATERIALS

A. Topsoil Type T1:
   1. Excavated and reused material.
   2. Graded.
   3. Soil shall be free of roots, twigs, stones, subsoil, debris, weeds, and foreign matter larger than 1/2-inch.
   4. Topsoil shall be evaluated in accordance with ASTM D5268.
   5. Contractor shall provide 10 lb sample of excavated and reused material to laboratory for soil classification analysis conforming to ASTM D2487.

B. Topsoil Type T2:
   1. Imported borrow.
   2. Friable loam.
   3. Soil shall be free of roots, twigs, stones, subsoil, debris, weeds, and foreign matter larger than 1/2-inch.
   4. Acidity range (pH) of 5.5 to 7.5.
   5. Containing minimum of four (4) percent and maximum of 25 percent inorganic matter.
   6. Limit decaying matter to five (5) percent of total content by volume.
   7. Topsoil shall be evaluated in accordance with ASTM D5268.
   8. Contractor shall provide 10 lb sample of proposed imported borrow material to laboratory for soil classification analysis conforming to ASTM D2487.

C. Topsoil Type T3:
   1. Shall be used as surface layer at locations shown on plans, with a compacted depth of 1.5 feet.
   2. Shall be placed over Subsoil Type S3.
   3. Shall be comprised of 50 percent sand, meeting the requirements for Aggregate Type A12, and 50 percent loam, by volume.
   4. Graded and screened to be free of lumps larger than 1/2-inch diameter.
   5. Free of rocks larger than 1/2-inch diameter; and organic matter, including organic soils, roots and tree material, and vegetation.
   6. Free of debris and foreign objects.
   7. Contractor shall provide 10 lb sample for each 500 cubic yards delivered or processed for laboratory classification analysis conforming to ASTM D2487.

2.3 SOURCE QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Testing and analysis of soil material.

B. Testing and Analysis of Topsoil Material designated for Landscaping Purposes: Perform in accordance with ASTM D5268.

C. When tests indicate materials do not meet specified requirements, change material and retest.

D. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 310516
AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aggregate materials and designations for utility structure aggregate base course.
   2. Aggregate materials and designations for pavement aggregate base course.
   3. Aggregate materials and designations for backfill.
   4. Aggregate materials and designations for grading purposes.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 024113 – Site Demolition.
   3. Section 024114 – Utility Abandonment and Removal.
   4. Section 310513 – Soils for Earthwork.
   5. Section 312213 - Rough Grading.
   6. Section 312317 – Site Excavation, Backfill, and Compaction.
   7. Section 312513 – Erosion and Sediment Control: Erosion control requirements.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
   1. Standard Specifications for Highway and Structure Construction, Current Edition. http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

B. ASTM International (ASTM):
   1. ASTM C33 – Standard Specification for Concrete Aggregates.
   2. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Product Data: Submit gradation information for each type of aggregate specified. Gradation results shall be taken within the past three (3) months from contract date.

C. Samples: Submit, in airtight containers, 10 lb sample of each type of fill to testing laboratory.

D. Materials Source: Submit name of source of imported materials.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation standards.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIALS

A. Aggregate Type A1 (Gravel): Crushed Gravel: free of organic matter and debris; graded in accordance with:
   1. WISDOT 3/4-Inch Gradation.

B. Aggregate Type A2 (Gravel): Crushed Gravel: free of organic matter and debris; graded in accordance with:
   1. WISDOT 1-1/4-Inch Gradation.

C. Aggregate Type A3 (Recycled): Crushed Concrete; free of from wood, steel, roots, bark or other extraneous material; graded in accordance with:

1. WISDOT 1-1/4-Inch Gradation.

D. Aggregate Type A6 (3/8-Inch Stone Chips): Crushed stone; free of clay, shale, organic matter; graded in accordance with the following limits:

Sieve Size	Percent Passing
1/2-inch	100
3/8-inch	85 - 100
No. 4	10 – 30
No. 8	0 - 10
No. 16	0 – 5

E. Aggregate Type A7 (3/4-Inch Stone Chips): Crushed stone; free of clay, shale, organic matter; graded in accordance with the following limits:

Sieve Size	Percent Passing
1-inch	100
3/4-inch	90 - 100
3/8-inch	20 - 55
No. 4	0 - 10
No. 8	0 – 5

F. Aggregate Type A9 (Granular Fill): Natural gravel/stone; free of clay, shale, organic matter; graded in accordance with:

1. WISDOT Granular Fill, Type 2.

G. Aggregate Type A10 (Bank Run Sand/Gravel): Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with following limits:

Sieve Size	Percent Passing
2-inch	95 - 100
No. 4	35 - 60
Finer Than No. 200	5 - 15

H. Aggregate Type A11 (Drainage Aggregate): Crushed stone; free of clay, shale, organic matter; graded in accordance with the following limits:

Sieve Size	Percent Passing
1-inch	100 - 75
3/4-inch	50 - 75
No. 4	0 - 60
No. 40	0 - 50
No. 200	0 – 5

I. Aggregate Type A12 (Bedding Sand): Unwashed bank-run sand or rejected concrete sand; approximately six (6) percent fine clay or loam particles but free of silt and clay or loam lumps consisting of durable particles ranging in size from fine to coarse in uniform combinations; maximum moisture content shall be 10 percent, graded within following limits:

Sieve Size	Percent Passing
1-inch	100
No. 16	45 - 80
No. 200	2 - 10

2.2 SOURCE QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Testing and analysis of aggregates.

B. When tests indicate materials do not meet specified requirements, change material or material source and retest.

C. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 311000
SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removal of grass and vegetation.
   2. Herbicide application.
   3. Removal of site debris.
   4. Clearing activities near existing permanent utilities and structures.
   5. Protection of project entrances and exits.

B. Related Sections:
   1. Applicable provisions of Section 310200 - General Requirements for Sitework shall govern Work under this Section.
   2. Section 311300 - Tree Removal and Grubbing: Removal of trees and saplings including stumps and roots.
   3. Section 312213 - Rough Grading: Removal of topsoil and subsoil.
   4. Section 312317 – Site Excavation, Backfill, and Compaction: Backfill and compaction of cleared areas.
   5. Section 312513 – Erosion and Sediment Controls..

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
   1. Standard Specifications for Highway and Structure Construction, Current Edition. http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

B. State of Wisconsin Department of Natural Resources (WDNR):
   1. Construction Site Erosion & Sediment Control. http://dnr.wi.gov/topic/stormwater/

C. U.S. Environmental Protection Agency (USEPA):
   1. Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites. http://cfpub.epa.gov/npdes/stormwater/swppp.cfm

1.3 DEFINITIONS

A. Root Zone - Area around a tree extending as far from tree base as longest horizontal branches.

B. Surface Water - Soil water that flows through ditch lines, creeks, and streams by gravity.

C. Clearing - Cutting down of bushes and trees and the digging and removal of their roots and stumps.

D. Clearing Limits - Area designated on Drawings scheduled for clearing operations within project site or right-of-way.

E. Herbicide - Post emergence type, used to kill entire plant or vegetation, including root system.

1.4 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Submit product data for herbicide, including manufacturer's instructions, usage, and hazardous materials sheets.

1.5 REGULATORY REQUIREMENTS

A. Contractor shall comply with local, state, and federal regulations applicable to Work of this Section.

B. Contractor shall comply with and be solely responsible for compliance with U.S. Department of Labor OSHA Part 1926 Safety and Health Regulations for Construction for this Work.

C. Contractor performing Work of this Section shall be solely responsible for identifying, furnishing, installing and maintaining equipment and materials required by State and Federal regulations to establish safe working conditions during Work of this Section.

D. Conform to applicable code for environmental requirements, disposal of debris, burning debris on site and use of herbicides.

E. Coordinate clearing Work with utility companies.

PART 2 PRODUCTS

2.1 MATERIALS

A. Herbicide:

1. Post-Emergence Herbicide: Water soluble and deactivate upon contact with soil, leaving no harmful residue; vegetation control herbicide when applied to leaves and stems of plants, is absorbed and translocated to all parts of plant including roots and underground stem; capable of killing entire plant.

PART 3 EXECUTION

3.1 NOTIFICATION

A. Contractor, prior to any excavation work, shall notify (1) a designated locating service; (2) utilities, governmental agencies, entities, known to, or which can reasonably be assumed to, have above or below ground pipe, conduit cables, structures, or similar items within limits of project; to locate and mark location of such items.

B. In accordance with Wisconsin Statute 182.0175, "Damage to Transmission Facilities," Excavator, as defined in 182.0175(1)(bm), shall be solely responsible to provide advance notice to “One-Call System - Diggers Hotline” (811) or (800) 242-8511, not less than three (3) working days prior to commencement of any Excavation, as defined in the statute, required to perform work contained in this Project, and further, Excavator shall comply with all other requirements of this Statute relative to Excavation.

Wisconsin Statute 182.0175 - Damage to Transmission Facilities

3.2 PREPARATION

A. Verify erosion control is in place prior to start of Work.

B. Verify that existing plant life designated to remain is tagged or identified and protected.

C. Identify a temporary waste area for placing removed materials.

3.3 PROTECTION

A. Maintain and repair damaged erosion control items throughout Work.

B. Protect utilities that remain, from damage.

C. Do not divert or relocate surface water without prior written approval from Owner’s Representative.

D. Protect trees, plant growth, and features designated to remain as final landscaping.

E. Protect benchmarks, survey control points, and existing structures from damage or displacement.

F. Keep entrances and exits, and adjacent roadways affected, free of debris from clearing operations.

3.4 CLEARING

A. Clear area required for access to site and execution of Work.

B. Remove trees and shrubs within marked areas. Remove stumps and root zone completely.

C. Remove surface rock larger than two (2) inches.

D. Clear undergrowth and deadwood, without disturbing subsoil.

E. Apply herbicide to remaining stumps to inhibit growth.

3.5 REMOVAL

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

B. Notify Owner's Representative if underground storage tanks and piping is uncovered during Work.

C. Cease work in immediate area of tanks until direction is given to proceed.

END OF SECTION

SECTION 31 13 00
TREE REMOVAL AND GRUBBING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removal of designated trees and saplings on site and disposal off site.
   2. Grubbing and disposal off site of stumps and tree/sapling root systems.
   3. Protection of existing trees, saplings, shrubs and other plant life designated to remain.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 311000 - Site Clearing: Removal of trees, shrubs and other vegetation.
   3. Section 312213 - Rough Grading: Removal of topsoil and subsoil.
   4. Section 312513 – Erosion and Sediment Controls.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
   1. Standard Specifications for Highway and Structure Construction, Current Edition. http://roadwaystandards.dot.wi.gov/standards/stndspec/index.htm

B. State of Wisconsin Department of Natural Resources (WDNR):
   1. Construction Site Erosion & Sediment Control. http://dnr.wi.gov/topic/stormwater/

C. U.S. Environmental Protection Agency (USEPA):
   1. Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites. http://cfpub.epa.gov/npdes/stormwater/swppp.cfm

1.3 DEFINITIONS

A. Tree - Woody perennial plant, single main stem with trunk, diameter of six (6) inches or greater. Multiple-stem trees with forks up to four (4) feet from ground elevation shall be considered a cluster of trees. Trees that fork above four (4) feet shall be considered a single tree.

B. Sapling - Woody perennial plant with single stem with trunk less than six (6) inches in diameter.

C. Root Zone - Area around a tree extending as far from tree base as longest horizontal branches.

D. Surface Water - Soil water that flows through ditch lines, creeks, and streams by gravity.

E. Grubbing - Clearing project site by removing roots and stumps.

F. Clearing - Cutting down bushes and trees and digging and removing their roots and stumps.

G. Clearing Limits - Area designated on Drawings scheduled for clearing operations within project site, right-of-way, or easement.

1.4 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Submit product data for herbicide, including manufacturer's instructions, usage, and hazardous materials sheets.

1.5 REGULATORY REQUIREMENTS

A. Contractor shall comply with local, state, and federal regulations applicable to Work of this Section.

B. Contractor shall comply with and be solely responsible for compliance with U.S. Department of Labor OSHA Part 1926 Safety and Health Regulations for Construction for this Work.

C. Contractor performing Work of this Section shall be solely responsible for identifying, furnishing, installing and maintaining equipment and materials required by State and Federal regulations to establish safe working conditions during Work of this Section.

D. Conform to applicable code for environmental requirements, disposal of debris, and use of herbicides.

E. Coordinate clearing Work with utility companies.

PART 2 PRODUCTS

2.1 MATERIALS

A. Herbicide:

1. Post-Emergence Herbicide: Water soluble and deactivate upon contact with soil, leaving no harmful residue; vegetation control herbicide when applied to leaves and stems of plants, is absorbed and translocated to all parts of plant including roots and underground stem; capable of killing entire plant.

PART 3 EXECUTION

3.1 NOTIFICATION

A. Contractor, prior to any excavation work, shall notify (1) a designated locating service; (2) utilities, governmental agencies, entities, known to, or which can reasonably be assumed to, have above or below ground pipe, conduit cables, structures, or similar items within limits of project; to locate and mark location of such items.

B. In accordance with Wisconsin Statute 182.0175, "Damage to Transmission Facilities," Excavator, as defined in 182.0175(1)(bm), shall be solely responsible to provide advance notice to “One-Call System - Diggers Hotline” (811) or (800) 242-8511, not less than three (3) working days prior to commencement of any Excavation, as defined in the statute, required to perform work contained in this Project, and further, Excavator shall comply with all other requirements of this Statute relative to Excavation.

Wisconsin Statute 182.0175 - Damage to Transmission Facilities

3.2 PREPARATION

A. Verify erosion control is in place prior to start of Work.

B. Verify that existing plant life designated to remain is tagged or identified and protected.

C. Identify a temporary waste area for placing removed materials.

3.3 PROTECTION

A. Maintain and repair damaged erosion control items throughout Work.

B. Protect utilities that remain from damage.

C. Do not divert or relocate surface water without prior written approval from Owner’s Representative.

D. Protect trees, plant growth, and features designated to remain as final landscaping.

E. Protect benchmarks, survey control points, and existing structures from damage or displacement.

F. Keep entrances, exits, and adjacent affected roadways free of debris from clearing operations.

3.4 CLEARING

A. Clear area required for access to site and execution of Work.

B. Remove trees and shrubs, within marked areas, completely.

C. Clear undergrowth and deadwood, without disturbing subsoil.

D. Remove surface rock larger than two (2) inches

E. Apply herbicide to remaining stumps to inhibit growth.

3.5 REMOVAL

A. Remove tree and grubbing debris, and extracted plant life from site.

B. Notify Owner's Representative if non-identified underground storage tanks or piping are uncovered during Work.

C. Cease work in immediate area of non-identified tanks and piping until direction is given to proceed.

END OF SECTION

SECTION 312213
ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removal of topsoil and subsoil.
   2. Cutting, grading, filling, rough contouring and compacting site for utility structures and pavements.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 024113 – Site Demolition.
   3. Section 024114 – Utility Abandonment and Removal.
   4. Section 310513 – Soils for Earthwork.
   5. Section 310516 – Aggregates for Earthwork.
   6. Section 311000 - Site Clearing.
   7. Section 312317 – Site Excavation, Backfill, and Compaction.
   8. Section 312513 – Erosion and Sediment Controls.
   9. Section 320100 – Site Restoration: Restoration of areas disturbed or damaged during construction.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
   1. Standard Specifications for Highway and Structure Construction, Current Edition. State of Wisconsin DOT Standard Specifications

B. ASTM International (ASTM):
   1. ASTM C136 – Test Method For Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft.-lbf/ft^3.
   3. ASTM D6938 – Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 CLOSEOUT SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for project closeout submittals.

1.4 QUALITY ASSURANCE

1. Perform Work in accordance with Wisconsin Department of Transportation standards.

PART 2 PRODUCTS

2.1 MATERIALS

A. Topsoil: Type T1, T2, or T3 as specified in Section 310513 – Soils for Earthwork.

B. Subsoil Fill: Type S1, S2, or S3 as specified in Section 310513 – Soils for Earthwork.

C. Aggregate Fill: Type A2, A3, or A9 as specified in Section 310516 – Aggregates for Earthwork.

PART 3 EXECUTION

3.1 NOTIFICATION

A. Contractor, prior to any excavation work, shall notify (1) a designated locating service; (2) all utilities, governmental agencies, entities, known to, or which can reasonably be assumed to have above or below ground pipe, conduit cables, structures, or similar items within limits of project; to locate and mark location of such items.

B. In accordance with Wisconsin Statute 182.0175, "Damage to Transmission Facilities," Excavator, as defined in 182.0175(1)(bm), shall be solely responsible to provide advance notice to “One-Call System - Diggers Hotline” (811) or (800) 242-8511, not less than three (3) working days prior to commencement of any Excavation, as defined in the statute, required to perform work contained in this Project, and further, Excavator shall comply with all other requirements of this Statute relative to Excavation.

Wisconsin Statute 182.0175 - Damage to Transmission Facilities

3.2 EXAMINATION

A. Section 310200 – General Requirements for Sitework: Verification of existing conditions before starting work.

B. Verify project survey benchmarks and intended elevations are as indicated on Drawings.

3.3 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect utilities, indicated to remain, from damage.

D. Protect above and below grade utilities indicated to remain.

E. Protect plant life, lawns, and other features remaining as portion of final landscaping.

F. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.4 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site to depth not exceeding eight (8) feet and protect from erosion.

D. Protect stockpiled material from erosion. Provide silt fencing or other approved erosion prevention method.

E. Remove excess topsoil from site.

F. Excess topsoil not desired by the Owner shall be disposed of off-site and shall become property of the Contractor.

G. Owner reserves the right to have excess topsoil from site delivered and stockpiled at location on the Zoo property as directed by Owner.

3.5 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded.

B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.

C. When excavating through roots, perform Work by hand and cut roots with sharp ax.

D. Excess subsoil not desired by the Owner shall be disposed of off-site and shall become property of the Contractor.

E. Owner reserves the right to have excess subsoil from site delivered and stockpiled at location on the Zoo property as directed by Owner.

F. Stockpile subsoil in area designated on site to depth not exceeding eight (8) feet and protect from erosion.

G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key placed fill material to slope to provide firm bearing.

H. Stability: Replace damaged or displaced subsoil as specified for fill.

3.6 FILLING

A. Install Work in accordance with Wisconsin Department of Transportation Standards.

B. Fill areas to contours and elevations with unfrozen materials.

C. Place fill material on continuous layers and compact in accordance with schedule at end of this section.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Slope grade away from building minimum two (2) inches in 10 feet, unless noted otherwise.

F. Make grade changes gradual. Blend slope into level areas.

G. Remove surplus fill materials from site.

3.7 TOLERANCES

A. Section 310200 – General Requirements for Sitework: Tolerances.

B. Top Surface of Subgrade: Plus or minus 1/10-foot from required elevation.

3.8 FIELD QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Testing and inspection services.

B. Testing and Analysis of Fill Material: In accordance with ASTM D1557.

C. Density and Moisture Testing: In accordance with ASTM D6938.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

E. Frequency of Tests: As determined by Geotechnical Engineer and Testing Agency.

3.9 SCHEDULES

A. Aggregate Fill:
   1. Fill Type A2, A3, or A9: Maximum seven (7)-inch loose lifts.
   2. Compact each lift to minimum 95 percent of modified Proctor density.

B. Subsoil Fill:
   1. Fill Type S1 or S2: Maximum 12-inch loose lifts. Compact each lift to minimum 95 percent of modified Proctor density.
   2. Fill Type S3: Maximum 7-inch loose lifts. Compact each lift to minimum 95 percent modified Proctor density.

C. Topsoil Fill:
   1. Fill Type T1 or T2: Maximum 12-inch loose lifts. Compact each lift to minimum 85 percent of modified Proctor density.
   2. Fill Type T3: Maximum 7-inch loose lifts. Compact each lift to minimum 90 percent modified Proctor density.

END OF SECTION

SECTION 312317
SITE EXCAVATION, BACKFILL, AND COMPACTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Verification of subsurface conditions and utilities prior to excavation.
   2. Saw cutting of pavements prior to excavation.
   3. Excavation for building and utility structure foundation.
   4. Excavation for slabs-on-grade.
   5. Excavation of trenches for utility systems.
   6. Utility structure backfilling to subgrade elevations.
   7. Backfill under slabs-on-grade.
   8. Backfill requirements for utility trenches.
   9. Backfill for over-excavation corrections.
   10. Consolidation and compaction.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 310516 – Aggregates for Earthwork: Aggregate backfill materials.
   3. Section 312213 - Rough Grading: Topsoil and subsoil removal from site surface.
   4. Section 312319 – Site Dewatering: Dewatering excavations and water control.
   5. Section 312513 – Erosion and Sediment Controls.
   6. Section 321123 – Aggregate Base Course: Preparation for aggregate base course.
   7. Section 334100 – Site Storm Sewer System: Installation of storm sewer system.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation (WISDOT):
   1. Standard Specifications for Highway and Structure Construction, Current Edition. State of Wisconsin DOT Standard Specifications

B. ASTM International (ASTM):
   1. ASTM C518 - Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   2. ASTM C578 – Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   3. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft.-lbf/ft^3.
   4. ASTM D1621 - Test Method for Compressive Properties of Rigid Cellular Plastics.
   5. ASTM D2842 - Test Method for Water Absorption of Rigid Cellular Plastics.
   6. ASTM D6938 – Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Samples: Submit 10 lb. sample of each type of specified fill to testing laboratory, in airtight containers.

C. Provide certified analysis of material(s) to Engineer prior to any use on Work.

1.4 REGULATORY REQUIREMENTS

A. Contractor shall comply with all local, state, and federal regulations applicable to Work of this Section.

B. Contractor shall comply with and be solely responsible for compliance with U.S. Department of Labor OSHA Part 1926 Safety and Health Regulations for Construction for this Work.

C. Contractor performing Work of this Section shall be solely responsible for identifying, furnishing, installing and maintaining equipment and materials required by state and federal regulations to establish safe working conditions during Work of this Section.

PART 2 PRODUCTS

2.1 BEDDING AND BACKFILL MATERIALS

A. Water Main Bedding: Type A12, as defined in Section 310516 – Aggregates for Earthwork.

B. Sewer Bedding (18 Inches in Diameter and Less): Type A6, as defined in Section 310516 – Aggregates for Earthwork.

C. Crushed Gravel Backfill: Type A2 or A3 as defined in Section 310516 – Aggregates for Earthwork.

D. Site Excavated Material (Spoil) Backfill: Type S1 as defined in Section 310513 – Soils for Earthwork.

E. Imported Subsoil Material Backfill: Type S2 or S3 as defined in Section 310513 – Soils for Earthwork.

2.2 PIPE INSULATION

A. Extruded polystyrene board to ASTM C578, Type V, rigid, closed cell type, with integral high density skin.

1. Thermal Resistance: Typical 5 year aged value of R-5 per 1 inch of thickness per ASTM C518.
2. Board Size: As indicated on the Drawings.
3. Compressive Strength: Minimum 100 psi per ASTM D1621.
4. Water Absorption: 0.7 percent by volume maximum per ASTM D2842.
5. Insulation shall be:
   a. Dow Chemical Company STYROFOAM™ Highload 100; Dow Chemical Styrofoam Highload 100 Insulation.
   b. Or Approved Equal.

PART 3 EXECUTION

3.1 NOTIFICATION

A. Contractor, prior to any excavation work, shall notify (1) a designated locating service; (2) all utilities, governmental agencies, entities, known to, or which can reasonably be assumed to have above or below ground pipe, conduit cables, structures, or similar items within limits of project; to locate and mark location of such items.

B. In accordance with Wisconsin Statute 182.0175, "Damage to Transmission Facilities," Excavator, as defined in 182.0175(1)(bm), shall be solely responsible to provide advance notice to “One-Call System - Diggers Hotline” (811) or (800) 242-8511, not less than three (3) working days prior to commencement of any Excavation, as defined in the statute, required to perform work contained in this Project, and further, Excavator shall comply with all other requirements of this Statute relative to Excavation.

Wisconsin Statute 182.0175 - Damage to Transmission Facilities

3.2 SITE VERIFICATION

A. Verify that survey benchmark and intended elevations for Work are as indicated.

3.3 FIELD MEASUREMENTS

A. Verify that survey benchmark and intended elevations for the Work are as shown on Drawings.

B. Primary line and grade will be furnished by Owner and will be established by Contractor.

C. Contractor shall employ a Registered Land Surveyor, registered in the State of Wisconsin to perform all survey work related to primary line and grade for project utilities.

D. Contractor shall check accuracy of line and grade stakes by means of visual and taping checks and shall be responsible for protection and preservation of such stakes established by Registered Land Surveyor.

E. Contractor shall bear sole responsibility for correct transfer of all construction lines and grades from primary line and grade points and for correct alignment and grade of finished structure, based upon primary line and grade established by Registered Land Surveyor.

F. Except for those lot corners and survey monuments that fall within trench excavation, Contractor shall be solely responsible for protection and/or replacement of all survey corners that exist throughout work area.

G. Corners will be located and marked by Owner, upon request by Contractor, prior to commencing its work.

H. A Registered Land Surveyor shall replace damaged corners at Contractor's expense.

3.4 SAWING AND BREAKING PAVEMENT

A. Saw cut asphalt surface course and asphalt binder course full depth before removal.

B. Cut pavements evenly along edges of excavation prior to their removal in such a way as to avoid excessive removal or ragged, uneven edges.

3.5 PREPARATION FOR EXCAVATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Protect above and below grade utilities indicated to remain.

D. Protect plant life, lawns and other features remaining as portion of final landscaping.

E. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

F. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with Type A2, A3, or A9, as specified in Section 310516 – Aggregates for Earthwork, fill and compact to density equal to or greater than requirements for subsequent backfill material.

3.6 FIELD QUALITY CONTROL FOR EXCAVATION

A. Field inspection will be performed under provisions of Section 310200 – General Requirements for Sitework.

B. Provide for visual inspection of bearing surfaces.

3.7 BUILDING AND UTILITY STRUCTURE EXCAVATION

A. Underpin adjacent structures that may be damaged by excavation work, including utilities and pipe chases.

B. Excavate subsoil required to accommodate building foundation, slabs-on-grade, utility structures, and construction operations.

C. Machine slope banks to angle of repose or less, until shored.

D. Excavation cut not to interfere with normal 45 degree bearing splay of foundation.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

F. Hand trim excavation. Remove loose matter.

G. Remove lumped subsoil, boulders, and rock.

H. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

I. Correct unauthorized excavation at no extra cost to Owner.

J. Correct areas over-excavated in error.

K. Stockpile excavated material in area designated on site and remove excess material not being reused, from site.

3.8 EXPOSING EXISTING UTILITIES

A. Before excavation of trench is begun, Contractor shall uncover stub end of existing utility to which new utility is to be connected. This will permit adjustments in line and grade and verify connection required.

B. Securely plug existing terminations in manholes to which new utilities are to be connected to prevent entry of construction water and debris into active system.

C. Contractor shall be responsible to verify that plug(s) are in place at end of each workday.

D. Contractor shall remove any water or debris from terminal manhole as required but not less than once a week.

3.9 TRENCH EXCAVATION

A. Excavate subsoil required for installation of utility.

B. Excavate trenches at top of pipe to a maximum width based on dimension of outside diameter of pipe plus 24 inches to enable installation of pipe and to allow inspection.

C. Width at top of pipe may be increased with prior approval of Engineer to allow for stringers and sheathing when required.

D. Provide pipe laid in open-cut trench with six (6) inch minimum clearance between outside face of pipe barrel and face of sheathing or sidewall of trench.

E. Maximum width of trench at ground surface shall not exceed width of trench at top of pipe by more than two (2) feet without prior request to Engineer, unless it is specifically allowed on Drawings.

F. Place excavated material stored along trench excavation a minimum distance back from edge of trench. Determine distance by angle of repose of trench material to prevent surcharging of trench wall material leading to potential shearing of trench wall and collapse of trench.

G. Store excavated material to be used for trench backfilling so that it will not interfere with:

1. Public travel.
2. Other Contractors.

H. Contractor shall immediately remove and dispose of excavated material which is not to be used as trench backfill, unless directed otherwise by Contract Documents.

I. Contractor shall maintain all finished excavations free of water or sewage during Work.

J. Hand trim excavation. Remove loose matter.

K. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard, measured by volume.

L. Correct unauthorized excavation and over-excavated areas at no cost to Owner.

M. Excavate no more trench in advance of completed pipe laying operations than can be completed and backfilled by end of workday.

3.10 TRENCH BEDDING

A. Keep trench bottom free of water prior to placement of bedding and laying of pipe.

B. Place and shape bedding material to pipe, to a minimum depth of three inches under bell and four inches under spigot and compact to 95 percent modified Proctor density.

C. Support pipe during placement and compaction of bedding material.

D. Bring bedding and cover material over top of pipe to a minimum compacted depth of 12 inches, compact to specified density.

E. Where sand is used for cover material, compact sand with portable plate compactor to a depth of twelve inches in two lifts of six (6) inches each for initial cover over pipe.

3.11 PIPE INSULATION

A. Insulate water pipes with less than six (6) foot of cover with a sheet of extruded polystyrene insulation as indicated on the Drawings.

B. Laterals with less than 42-inch cover shall have a minimum four (4) inch thick sheet of extruded polystyrene insulation.

3.12 PROTECTION

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

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

3.13 EXAMINATION PRIOR TO BACKFILLING

A. Verify fill material to be reused are acceptable.

3.14 BACKFILLING

A. Backfill with materials and to contours and elevations shown on Drawings. Generally, compact subgrade to density requirements for subsequent backfill materials.

B. Place specified backfill in loose lift layers. Use compaction equipment that will achieve desired compaction requirements.

C. Systematically backfill to allow for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

D. Where sidewall material is loose or unstable, place geotextile cloth material over sidewall prior to backfilling.

E. Employ a placement method that does not disturb or damage pipe in trench.

F. Maintain optimum moisture content of backfill materials to attain required compaction density.

G. Backfill against supported foundation walls that have a basement or underground parking area. Do not backfill against unsupported foundation walls that have a basement or underground parking area.

H. Backfill simultaneously on each side of unsupported non-basement foundation walls.

I. Make grade changes gradual. Blend slope into level areas.

J. Leave fill material stockpile areas completely free of excess fill materials.

K. Remove surplus backfill materials from site.

3.15 MECHANICAL COMPACTION

A. Mechanically compact backfill by means of a tamping roller, sheepsfoot roller, pneumatic tire roller, vibrating roller, or other mechanical tampers. Impact, free-fall, or "stomping" type compaction equipment shall not be allowed.

B. Flooding or jetting of backfill for compaction purposes shall not be allowed.

C. Contractor shall furnish written notification to Engineer prior to start of work as to size and type of mechanical compaction equipment to be used.

D. Place material for mechanically compacted backfill in lifts, which, prior to compaction, shall not exceed thickness specified below for type of compaction equipment used:

1. Vibratory equipment including vibratory plate, vibratory smooth-wheel rollers, and vibratory pneumatic-tired rollers: maximum lift thickness two (2) feet.
2. Rolling equipment, including sheepsfoot (both vibratory and non-vibratory), grid, smooth-wheel (non-vibratory), pneumatic-tired (non-vibratory), and segmented wheels: maximum lift thickness one (1) foot.
3. Hand-directed mechanical tampers: maximum lift thickness of six (6) inches.

3.16 TOLERANCES FOR BACKFILL

A. Top Surface of Backfill: Plus or minus 1 inch from required elevations.

3.17 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 310200 - General Requirements for Sitework.

B. Testing and analysis of fill material will be performed in accordance with ASTM D1557 and Section 310200 - General Requirements for Sitework.

C. Compaction and moisture testing will be performed in accordance with ASTM D6938 and Section 310200 - General Requirements for Sitework.

D. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest at no cost to Owner.

3.18 PROTECTION OF FINISHED WORK

A. Reshape and recompact fills subjected to vehicular traffic.

B. Contractor shall have available a supply of steel plates with minimum dimensions of four (4) feet by eight (8) feet by one (1) inch.

C. Use plates to bridge open trenches and secure against possibility of shifting or dropping into excavation.

D. During winter months, do not leave plates in roadway overnight.

3.19 SCHEDULE OF BACKFILL

A. Section 310516 – Aggregates for Earthwork defines “A” designated fill materials and Section 310513 – Soils for Earthwork defines “S” designated fill materials.

B. Fill to Correct Over-Excavation:
   1. Aggregate Type A2, A3, or A9 fill, flush to required elevation, compacted to 90 percent modified Proctor density.

C. Foundations:
   1. Aggregate Type A2 or A3 fill. Place materials in continuous loose lifts layers not exceeding seven (7) inch depth, compacted to 95 percent modified Proctor density.

D. Below Grade Slabs and Basement Slabs:
   1. Aggregate Type A7 fill. Place materials in continuous loose lifts layers not exceeding nine (9) inch depth, compacted to 95 percent modified Proctor density.

E. Interior Slab-On-Grade:
   1. Aggregate Type A1 or A2 fill. Place materials in continuous loose lifts layers not exceeding seven (7) inch depth, compacted to 95 percent modified Proctor density.

F. Exterior Slab-On-Grade:
   1. Aggregate Type A2 or A3 fill. Place materials in continuous loose lifts layers not exceeding seven (7)-inch depth, compacted to 95 percent modified Proctor density.

G. Utility Piping - Stone Bedding and Cover:
   1. Aggregate Type A6 or A7 fill depending on pipe size. Place materials in continuous loose lifts layers not exceeding nine (9) inch depth, compacted to 95 percent modified Proctor density.

H. Utility Piping - Sand Bedding and Cover:
   1. Aggregate Type A12 fill. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 95 percent modified Proctor density.

I. Utility Trench – Backfill in Paved Areas:
   1. Aggregate Type A2 or A3 fill. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 95 percent modified Proctor density.

J. Utility Trench – Backfill in Non-paved Areas:
   1. Subsoil Type S1 or S2 fill, to six (6) inches below finish grade. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 90 percent modified Proctor density.

K. Fill Under Grass Area.
   1. Subsoil Type S1 or S2 fill, to six (6) inches below finish grade. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 90 percent modified Proctor density.

L. Fill Under Landscaped Areas:
   1. Subsoil Type S1 or S2 fill, to 18 inches below finish grade. Place materials in continuous loose lifts layers not exceeding 12-inch depth, compacted to 85 percent modified Proctor density.

M. Special Fill in Animal Areas:
   1. Subsoil Type S3 fill, from 36 inches to 18 inches below finish grade per Section 312213 – Rough Grading.
   2. Topsoil Type T3, from 18 inches below finished grade to finished grade, per Section 312213 – Rough Grading.

N. Frequency of Compaction Tests:
   1. General Excavation and Fill: One (1) Test for Every 1000 Cubic Yards, or as required by the testing agency, whichever is more stringent.
   2. Excavation and Backfill for Trenches (Gravel): One (1) Test for Every 300 Cubic Yards, or as required by the testing agency, whichever is more stringent.
   3. Excavation and Backfill for Trenches (Spoil): One (1) Test for Every 750 Cubic Yards, or as required by the testing agency, whichever is more stringent.
   4. Undercut Excavation: One (1) Test for Every 1000 Cubic Yards, or as required by the testing agency, whichever is more stringent.

END OF SECTION

SECTION 312319
SITE DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements to keep excavations, trenches and other parts of Work dry during construction, including sumps, pumps and well points.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 312317 – Site Excavation, Backfill, and, Compaction.
   3. Section 312513 – Erosion and Sediment Control.

1.2 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

1.3 REGULATORY REQUIREMENTS

A. Contractor shall comply with applicable rules and regulations for dewatering operations in accordance with:
   1. State of Wisconsin Department of Natural Resources, (WDNR) -Storm Water Construction and Post-Construction Technical Standards.
      http://dnr.wi.gov/topic/Wells/dewatering.html
   2. Contractor shall comply with other local, state or federal agency having jurisdiction related to Work of this Section.

B. Contractor shall obtain permits applicable to work of this Section as required by the regulatory agencies. Comply with City of Milwaukee Construction Site Erosion Control Ordinance to control, handle, and dispose of ground and surface water.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. Contractor shall provide equipment and related accessories specifically applicable to dewatering work.

B. Equipment shall be operated and maintained in a manner to produce acceptable results.

PART 3 EXECUTION

3.1 REMOVAL AND DISPOSAL OF WATER

A. Provide equipment and methods to remove water entering excavations, trenches, and other parts of Work.

B. Maintain excavations and trenches relatively dry until construction is completed.

C. Do not place concrete structure in water or allow water to rise above new concrete structure and keep trenches and foundations dry until construction is complete.

D. Maintain water level at an elevation to prevent flotation of installed Work until backfilling or other means to prevent flotation are in place.

E. Use of a well point system shall be submitted to Engineer for review and comment prior to its use.

F. Contractor shall dispose of water from Work in accordance with applicable agency rules and regulations.

G. Unless prior approval is obtained, do not discharge ground or surface water to a sanitary or storm sewer.

H. Water may be allowed to drain through completed sewer work after masonry and concrete units have set up sufficiently to prevent damage.

I. If new sewer work is utilized for drainage, place a watertight plug in downstream end of new pipe at last manhole to prevent water from entering permanent sanitary or storm sewer system. Pump and properly dispose of water at this manhole.

J. Completely clean piping and manholes used for dewatering of debris and foreign material upon completion of dewatering and prior to use for its intended purpose.

K. Under no circumstances shall a water main be used for discharge of ground or surface water.

3.2 FLOODING OF STRUCTURES

A. Contractor shall be responsible for keeping pumps, motors, electrical systems, and equipment dry during construction.

B. Replace equipment, electrical and communication systems, or similar items submerged or water damaged during construction at no cost to Owner.

3.3 DEWATERING WELLS AND PUMPS

A. Dewatering sumps and wells shall be adequately sheathed and braced.

B. Drill dewatering wells and maintain in accordance with:
   1. State of Wisconsin (WDNR) rules and regulations.
   2. Contractor shall comply with other local, state or federal agency having jurisdiction related to Work of this Section.

C. Abandon dewatering wells at completion of Work in accordance with:
   1. State of Wisconsin (WDNR) regulations for abandonment of wells.
   2. Contractor shall comply with other local, state or federal agency having jurisdiction related to Work of this Section.

3.4 EXISTING ZOO WELL

A. Contractor shall be responsible for damage to, or contamination of, existing zoo well in area of Work as a result of its dewatering.

B. It is recommended that Contractor, prior to initiating project dewatering, inspect and sample existing wells that may be affected by dewatering operations to establish a pre-construction record.

C. Provide a copy of well inspection record to Engineer and Owner.

D. Contractor shall restore any well damaged by dewatering work to its original condition and acceptable use.

E. Contractor shall pay all costs of restoration and testing.

END OF SECTION

SECTION 312513
EROSION AND SEDIMENT CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment and materials for erosion and sediment control to minimize erosion and siltation during construction.
   2. Erosion and sediment control provisions detailed on Drawings and specified herein are minimum requirements for erosion control program.
   3. Contractor to provide additional erosion and sediment control materials and methods required by state or local ordinances, whichever is more stringent.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 312319 – Site Dewatering.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. ASTM D4491 – Test Methods for Water Permeability of Geotextiles by Permittivity.
   2. ASTM D4632 - Test Method for Grab Breaking Load and Elongation of Geotextiles.
   3. ASTM D4751 - Test Method for Determining Apparent Opening Size of a Geotextile.
   4. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

B. State of Wisconsin Department of Natural Resources (WDNR):
   1. Storm Water Construction Technical Standards, Models and Best Management Practices (BMP's):
      WDNR Storm Water Construction Technical Standards Webpage
   2. Storm Water Post-Construction Technical Standards:
      WDNR Storm Water Post-Construction Technical Standards Webpage

C. State of Wisconsin Department of Natural Resources – Conservation Practice Standards (WDNR - CPS);
   1. Non-Channel Erosion Mat: WDNR – CPS 1052.
   2. Sediment Bale Barrier (Non-Channel): WDNR – CPS 1055.
   3. Silt Fence: WDNR – CPS 1056.
   4. Stone Tracking Pad and Tire Washing: WDNR – CPS 1057.
   5. Mulching for Construction Sites: WDNR – CPS 1058.
   6. Seeding for Construction Site Erosion Control: WDNR – CPS 1059.
   7. Storm Drain Inlet Protection for Construction Sites: WDNR – CPS 1060.
   8. Dewatering: WDNR – CPS 1061.
   9. Dust Control on Construction Sites: (WDNR – CPS 1068).

D. State of Wisconsin Department of Transportation (WisDOT):
   1. Standard Specifications for Highway and Structure Construction, Current Edition.
   2. Erosion Control Product Acceptability Lists for Multi–Modal Applications. (PAL)

E. U.S. Environmental Protection Agency (USEPA):
   1. Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites. http://www.epa.gov/npdes/pubs/sw_swppp_guide.pdf

F. City of Milwaukee, Wisconsin
   1. Ordinance for Construction Site Erosion Control.

1.3 DEFINITIONS

A. Definitions shall be in accordance with Wisconsin Department of Natural Resources – Construction Practice Standards, as defined by each standard.

1.4 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Modify erosion control plan when site conditions dictate. Indicate proposed methods, materials, and schedule for effecting erosion and siltation control to prevent erosion damage to site and adjacent area.

C. Plan shall include following:
   1. Proposed methods for erosion and siltation control.
   2. Erosion plan scale of 1 inch equals 40 feet, indicating location of erosion control materials, siltation basins, etc.
   3. Schedule for implementation of plan.
   4. Provision for maintenance and upkeep of erosion control and siltation materials, identifying persons responsible for said maintenance.

1.5 REGULATORY REQUIREMENTS

A. Comply with City of Milwaukee ordinance for construction site erosion control.

B. Comply with applicable state and federal rules and regulations governing erosion and siltation on construction sites.

1.6 EROSION CONTROL PRINCIPLES

A. Keep disturbed area small.

B. Stabilize disturbed areas with mechanical or structural and vegetative methods.

C. Keep runoff low through use of short slopes, low gradients, and preservation of natural vegetative cover.

D. Protect disturbed areas from storm water runoff.

E. Retain sediment within construction limits.

F. Implement a thorough maintenance and follow-up program.

PART 2 PRODUCTS

2.1 MATERIALS

A. Non-Channel Erosion Matting: (WDNR CPS 1052)
   1. Only mats listed in WISDOT PAL will be accepted for use. Select erosion mats that last long enough for grass or other vegetation to become densely established.
   2. Class I, short-term duration (6 months or less), light duty, organic, “Erosion Control Revegetative Mat”, (ECRM). Non-organic, photodegradable or biodegradable netting allowed; Types as follows;
      a. Urban type mats shall conform to the following requirements;
         1) Shall be 100 percent biodegradable, including parent material, stitching and netting.
         2) Class 1, Type B Urban mats may be single, double or no netted products.
         3) Minimum mat thickness shall be 3/8-inch as measured in place.
         4) WISDOT PAL approved products in the Urban Type A category will be allowed on slopes up to 4:1.
         5) Slopes that are between 4:1 and 2.5:1 are required to use mats in the Urban Type B category.
         6) Netting shall be stitched to prevent separation of the net from the parent material.

7) Netting shall be capable of withstanding moderate foot traffic without tearing or puncturing, and shall be in accordance with Section 628 of the WisDOT Standard Specifications.

3. Documentation of materials used, monitoring logs, project diary, and weekly inspection forms including erosion and stormwater management plans, should be submitted to Engineer.
4. Use U-shaped wire staples, metal pins or wooden stakes to anchor mats and blankets to ground surface.
5. Staples shall be made of 0.12 inch steel wire and shall be U-shaped with 8-inch legs and 2-inch crown.
6. Wire staples shall be minimum of 11 gauge.
7. Metal stake pins shall be 0.188-inch diameter steel with a 1.5 inch steel washer at head of pin.
8. Staples or stakes shall be driven flush to soil surface.
9. Anchors shall have sufficient ground penetration to resist pullout by wind.
10. Loose soils may require longer anchors.

B. Sediment Bale Barrier (Non-Channel): (WDNR – CPS 1055)

1. Provide temporary sediment barrier consisting of entrenched and anchored straw bales, hay bales or equivalent material used to intercept sediment laden sheet flow from areas of disturbed soil.
   a. Erosion Bales: Tightly compacted bales of grain straw, hay, or other suitable material with approximate dimensions of 14 inches high, 18 inches deep, and 36 inches long, secured by a minimum of two strings.
2. Sediment bale barriers shall not be used under the following circumstances;
   a. Below the ordinary high water mark or placed perpendicular to flow in streams, swales, ditches or any place where flow is concentrated.
   b. Where the maximum gradient upslope of the sediment bale barriers is greater than 50 percent (2:1).

C. Silt Fence: (WDNR – CPS 1056)

1. Provide temporary silt fencing designed to intercept and slow the flow of sediment-laden sheet flow runoff from areas of disturbed soil.
2. Fence Geotextile Fabric:
   a. Geotextile fabric shall consist of either woven or non-woven polyester, polypropylene, stabilized nylon, polyethylene or polyvinylidene chloride.
   b. Non-woven fabric may be needle punched, heat bonded, resin bonded of a combination of.
   c. All silt fence geotextile fabric shall meet the following requirements;

Test Requirement	Method	Value
Minimum Grab Tensile Strength In the Machine Direction	ASTM D4632	120 lbs.
Minimum Grab Tensile Strength In the Cross Machine Direction	ASTM D4632	100 lbs.
Maximum Apparent Opening Size Equivalent (Standard Sieve)	ASTM D4751	No. 30
Minimum Permittivity	ASTM D4491	0.05 scc^{-4}
Minimum Ultraviolet Stability Percent of Strength Retained after 500 Hours of Exposure.	ASTM D 4355	70%

   d. Silt fence shall have a maximum flow rate of 10 gallons/minute/square foot at 50mm constant head as determined by multiplying permittivity in 1/second as determined by ASTM D4491 by a conversion factor of 74.
3. Silt Fence Supports: Silt fences shall be supported by either steel or wood supports specified as follows;
   a. Steel Supports:

1) The full height of the silt fence shall be supported by steel posts at least 5 feet long with a strength of 1.33 pounds per foot and have projections for the attachment of fasteners.

b. Wood Supports:

1) The full height of the silt fence shall be supported by 1-1/8 inch by 1-1/8-inches air or kiln-dried posts of hickory or oak.

D. Stone Tracking Pad and Tire Washing: (WDNR – CPS 1057)

1. Tracking Pad:
   a. Tracking pad shall be installed prior to any construction traffic leaving the site.
   b. Aggregate for tracking pads shall be 3 to 6 inch clear or washed stone. All material to be retained in a 3-inch sieve.
2. Tire Washing:
   a. Tire wash rack shall consist of a heavy grating over a lowered area. The rack shall be strong enough to support the vehicles that will cross it.

E. Mulching for Construction Sites: (WDNR – CPS 1058)

1. Mulch shall consist of natural biodegradable material such as plant residue, including but not limited to straw, hay, wood chips, bark and wood cellulose fiber, or other Engineer approved equivalent materials of sufficient dimension, depth or thickness, and durability to achieve the intended effect for the required time period.
2. Selected mulch shall be environmentally harmless to wildlife and plants. Materials such as gravel, plastic, fabric, sawdust, municipal solid waste, solid waste by-products, shredded paper and non-biodegradable products shall not be used.
3. Mulch shall be free of diseased plant residue, weed seeds, chemical residues, heavy metals, hydrocarbons and other known environmental toxicants.
4. Marsh hay shall not be used as mulch in lowland areas, but may be used in upland sites to prevent the spread of invasive, non-native species commonly found in marsh hay.
5. Straw and hay mulch that will be crimped shall have a minimum fiber length of 6 inches.
6. Wood chips or wood bark shall only be used for sites that are not seeded.

F. Seeding for Construction Site Erosion Control: (WDNR – CPS 1059)

1. Seed Selection:
   a. Seed mixtures that will produce dense vegetation shall be selected based on soil and site conditions and intended final use.
   b. All seed shall conform to the requirements of the Wisconsin Statutes and of the Administrative Code Chapter ATCP 20.01 regarding noxious weed seed content and labeling.
   c. Seed mixtures that contain potentially invasive species or species that may be harmful to native plant communities shall be avoided.
   d. Seed shall not be used later than one (1) year after the test date that appears on the label.
   e. Seed shall be tested for purity, germination and noxious weed seed content and shall meet the minimum purity and germination requirements as prescribed in the current edition of Rules for Testing Seed, published by the Association of Official Seed Analysts.
2. Seed Rates:
   a. Temporary Seeding (Cover Crop):
      1) Areas needing protection during periods when permanent seeding is not applied shall be seeded with annual species for temporary protection.
      2) Temporary Seeding Species and Rates as follows:

Species	lbs/Acre	Percent Purity
Oats	131[1]	98
Cereal Rye	131[2]	97
Winter Wheat	131[2]	95
Annual Ryegrass	80[2]	97

[1] Spring and Summer Seeding
[2] Fall Seeding

G. Storm Drain Inlet Protection for Construction Sites: (WDNR – CPS 1060)

1. Inlet protection products are intended to intercept, pond and filter sediment-laden runoff. Protection systems include geotextile fabric and fabric hold-down systems.
2. Materials:
   a. Fabric Material: Type FF, Woven polypropylene.
   b. Physical Properties:

Test	Method	Value[1]
Grab Tensile Strength, (lb.)	ASTM D4632	200 lbs
Puncture Strength, (lb.)	ASTM D4833	105 lbs (Min.)
Apparent Breaking Elongation Machine Direction, %	ASTM D4632	24 (Min.)
Apparent Breaking Elongation Cross Direction, %	ASTM D4632	10 (Min.)
Apparent Opening Size	ASTM D4751	600 (Max.)
Permittivity	ASTM D4491	1.9 (Min.)

(1) All numerical values represent minimum/maximum average roll values (i.e., the average of minimum test results on any roll in a lot should meet or exceed the minimum specified values).

3. Contractor shall have the responsibility of providing identification of the fabric supplied for inlet protection units. Types of inlet protection systems include the following;
   a. Type A, shall be utilized around field inlets until permanent stabilization methods have been established. Type A inlet protection shall be utilized on pavement inlets prior to installation of curb and gutter or pavement.
   b. Type B, shall be utilized on street inlets without curb head, once surrounding surfaces are in place.
   c. Type C, shall be utilized on street inlets with curb heads. Provide a 2 inch x 4 inch minimum, piece of wood and wrap and attach fabric to wood. Place wood blocking and fabric over inlet with wood straddling inlet opening a minimum of 8 inches in each direction. Secure 2 x 4 inch board to grate with wire or plastic ties. Verify and secure wood blocking to rest on inlet grate and that fabric covers remaining curb head opening. Wood blocking shall not block entire inlet curb opening.
   d. Type D, shall be utilized in areas where other types of inlet protection are identified as incompatible with roadway and traffic conditions causing possible safety hazards when water ponding occurs at the inlet. Provide inlet protection as detailed on Drawings.
4. Manufactured bags, such as sand bags used as inlet protection devices shall conform the following minimum criteria:
   a. Minimum Size = 14 x 26 inches.
   b. Grab Tensile Strength of Fabric (ASTM D4632) = 95 lbs minimum.
   c. UV Stability (ASTM D4355) = 70 percent minimum.

      Note: To provide sufficient strength, fabric shall be sewn together with double stitching.

H. Dust Control on Construction Sites: (WDNR – CPS 1068)
1. Provide one of or a combination of one of the following dust control practices for the duration of the project or until site is fully vegetated or paved.
   a. Asphalt and petroleum-based products shall not be used for project dust control.
   b. Provide mulch or seed and mulch to protect exposed site soil from both wind and water erosion. Reference WDNR – CPS 1058 and 1059 specified previously in this section.
   c. Provide water applications until surface is wet and repeat as necessary. Water shall be applied so it does not cause runoff.
   d. Provide tilling of soil with chisel type plows on exposed soils. Tillage shall be utilized only on flat areas of the project site.
   e. Provide tackifiers and soil stabilizers, Type A – Products shall be selected from and installed at rates in accordance with WisDOT Erosion Control PAL.

PART 3 EXECUTION

3.1 INSTALLATION

A. Non-Channel Erosion Matting: (WDNR CPS 1052)
   1. Install erosion mats and blankets in accordance with manufacturer's instructions.
   2. ECRMs shall be installed after all topsoiling, fertilizing, liming and seeding are complete.
   3. Erosion matting shall extend for whichever is greater:
      a. Upslope one foot minimum vertically from the ditch bottom; or 6 inches higher than the design flow depth.
   4. Matting shall be in firm and intimate contact with the soil. Matting shall anchored in accordance with matting manufacturer's written instructions.

B. Sediment Bale Barrier (Non-Channel): (WDNR – CPS 1055)
   1. Sediment Bale Barrier; (Hay or Straw)
      a. Place bales end to end across ditches or other location as designated on Drawings.
      b. Place bales at right angles to direction of water flow with bandings oriented around sides.
      c. Tightly abut ends of bales and fill gaps between bales with bale material wedged in.
      d. Embed straw bales a minimum 4 inches into ground.
      e. Securely anchor bales with at least two wood or steel stakes driven a minimum 12 inches into ground.
      f. Place bales such that one full bale length on either side of drainage way is above anticipated flow line.
      g. Where heavy flows are anticipated, supplement bales with a filter fabric fence installed on downstream side of bales.

C. Silt Fence: (WDNR – CPS 1056)
   1. When silt fence is installed as a stand-alone practice on a slope, silt fence shall be placed on the contour.
   2. The parallel spacing shall not exceed the maximum slope lengths for the appropriate slope as follows:

Slope	Fence Spacing
<2%	100 feet
2 to 5%	75 feet
5 to 10%	50 feet
10 to 33%	25 feet
>33%	20 feet

   3. Silt fences shall not be placed perpendicular to the contour.
   4. The ends of the silt fence shall be extended upslope to prevent water from flowing around the ends of the fence.
   5. Installed silt fences shall be a minimum 14 inches high and shall not exceed 28 inches in height measured from the installed ground elevation.
   6. Steel Supports:
      a. The full height of the silt fence shall be supported by steel posts at least 5 feet long with a strength of 1.33 pounds per foot and have projections for the attachment of fasteners.
      b. Silt fence shall be attached in at least 3 places on the support, on the upslope side with 50 pound plastic tie straps or wire fasteners.
      c. To prevent damage to the fabric from wire fastener, the protruding ends shall be pointed away from fabric.
   7. Wood Supports:
      a. The full height of the silt fence shall be supported by 1-1/8 inch by 1-1/8-inches air or kiln-dried posts of hickory or oak.
      b. Silt fence fabric shall be stapled, using at least 0.5-inch staples, to the upslope side of the posts in at least 3 places.
      c. Wood posts shall be a minimum of 3 feet long for 24-inch high silt fence, and a minimum of 4 feet for 36-inch silt fence fabric.
   8. The maximum spacing of posts for non-woven silt fence shall be 3 feet and for woven fabric, 8 feet.

9. Silt fence shall have a support cord.
10. Where joints are required to join the ends of fabric, each end of the fabric shall be securely fastened to a post. Posts shall then be wrapped around each other to produce a stable, secure joint or shall be overlapped the distance between two posts.
11. A minimum of 20 inches of the post shall extend into the ground after installation.
12. Silt fence shall be anchored by spreading at least 8 inches of the fabric in a 4-inch wide by 6-inch deep trench, or 6-inch deep V-trench on the upslope side of the fence.
13. Backfill anchoring trench and compact.
14. On the terminal ends of silt fence the fabric shall be wrapped around the post such that the staples are not visible.
15. Silt fencing shall at a minimum be inspected by the Contractor weekly and within 24 hours after every rain event that produces 1/2-inch of rain or more during a 24-hour period.
16. Damaged or decomposed fences, undercutting, or flow channels around the ends of silt fencing shall be repaired immediately after discovery.
17. Silt fencing and all accessories shall be removed completely once the disturbed area is permanently stabilized and no longer susceptible to erosion.

D. Stone Tracking Pad and Tire Washing: (WDNR – CPS 1057)
   1. Tracking Pad:
      a. Tracking pad shall be installed prior to any traffic leaving the site.
      b. Aggregate shall be placed in a layer at least 12 inches thick. Contractor shall supplement additional aggregate over life of project for repair or replenish aggregate to maintain functional tracking pad as specified.
      c. For sites with high water tables, or where saturated conditions are expected throughout the duration of the project, stone tracking pads shall be underlain with a WisDOT Type R Geotextile Fabric to prevent migration of underlying soil into the stone.
      d. Tracking pad shall be the full width of the egress point and a minimum 50 feet long.
      e. Contractor shall prevent surface water from passing through the tracking pad.
      f. Surface water flow shall be diverted away from tracking pads or conveyed under and around the tracking pad by Contractor's selected method of conveyance or diversion.
   2. Tire Washing:
      a. If tracking pad does not remove sediment from tires prior to entering roads or streets, Contractor shall provide pressurized water removal operation to wash tires clean prior to entering streets or roads.
      b. Rocks lodged between the tires of dual wheel vehicles shall be removed prior to leaving the construction site.

E. Mulching for Construction Sites: (WDNR – CPS 1058)
   1. Prepare soil surface prior to application of mulch in order to achieve the desired purpose and to ensure optimum contact between soil and mulch.
   2. All areas to be mulched shall be reasonably free of rills and gullies.
   3. Mulch shall cover a minimum of 80 percent of the soil surface for unseeded areas.
   4. For seeded area, mulch shall be placed loose and open enough to allow some sunlight to penetrate and air to circulate, but still cover a minimum of 70 percent of the soil surface.
   5. Mulch shall be applied at uniform rate of 1-1/2 to 2 tons per acre for sites that are seeded, and 2 to 3 tons per acre for sites that are not seeded.
   6. This application results in a layer of 1/2 to 1-1/2 inches thick for seeded sites, and 1-1/2 to 3 inches thick for sites that are not seeded.
   7. Wood chips or wood bark shall be applied at a rate of 6 to 9 tons per acre to achieve a minimum of 80 percent ground cover.
   8. This application should result in a layer of wood chips or wood bark 1/2-inch to 1-1/2 inches thick.
   9. Anchoring of mulch shall be based on the type of mulch applied, site conditions, and accomplished by one of the following techniques:
      a. Crimping: Immediately after spreading mulch, the mulch shall be anchored by a mulch crimper or equivalent device consisting of a series of dull flat discs with notched edges spaced approximately 8 inches apart. Mulch shall be impressed into the soil to a depth of 1 to 3 inches.
      b. Polypropylene Plastic or Biodegradable Netting: Apply plastic netting over placed mulch and staple according to netting manufacturer's written instructions.

c. Tackifier shall be sprayed in conjunction with mulch or immediately after the mulch has been placed. Tackifiers shall be selected from those approved by WISDOT PAL.
d. Tackifiers shall be applied at the following minimum application rates per acre, for each type of tackifier mixture defined as follows:
    1) Latex-Base: Mix 15 gallons of adhesive, or the manufacturer's recommended rate, whichever is greater, and a minimum of 250 pounds of recycled newsprint (pulp) as a tracer with 1,300 gallons of water.
    2) Guar Gum: Mix 50 pounds of dry adhesive, or the manufacturer's recommended rate, whichever is greater, and a minimum of 250 pounds of recycled newsprint (pulp) as a tracer with 1,300 gallons of water.
    3) Other Tackifiers (Hydrophilic Polymers): Mix 100 pounds of dry adhesive or the manufacturer's recommended rate, whichever is greater, and a minimum of 250 pounds of recycled newsprint (pulp) as a tracer with 1,300 gallons of water.

F. Seeding for Construction Site Erosion Control: (WDNR – CPS 1059)
1. Contractor shall perform site assessment to evaluate soil characteristics, topography, exposure to sunlight, proximity to natural plant communities, proximity to nuisance, noxious and invasive species, site history, moisture regime, climatic patterns, soil fertility, and previous herbicide applications prior to commencing any seeding operations.
2. Contractor shall use this information to establish seeding schedule including adjustment to existing soils in regards to preparation, fertility and seeding operations.
3. Use newly introduced seed species only in places where they will not spread into existing natural areas.
4. Seed grasses and legumes no more than 1/4-inch deep. Distribute seed uniformly.
5. Mixture with low seeding rates requires special care in sowing to achieve proper seed distribution.
6. Seed may be broadcast, drilled, or hydroseeded depending on site conditions.
7. Seeding shall be done in two equal passes in opposite directions to ensure adequate coverage.
8. Soils that are compacted shall require chisel plowing or other approved method to loosen compacted soil in preparation for seeding.
9. After seeding operations, lightly roll and compact the seeded area. Water and fertilize.
10. Do not over water seeded areas to prevent runoff, erosion and loss of seed.
11. Seed when soil temperatures remain consistently above 53 degrees F.
12. Dormant seed when the soil temperatures consistently below 53 degrees F, typically November 1st until snow cover.
13. Turf seedlings shall not be mowed until the stand is at least 6 inches tall. Leave cut turf at a minimum of 3 inches tall after mowing during the first year of turf establishment.

G. Storm Drain Inlet Protection for Construction Sites: (WDNR – CPS 1060)
1. Inlet protection devices are for drainage areas of one acre or less. Runoff from areas larger than one acre should be routed through a designed sediment trapping or settling practice upstream of the inlet.
2. Type A, shall be utilized around field inlets until permanent stabilization methods have been established. Type A inlet protection shall be utilized on pavement inlets prior to installation of curb and gutter or pavement.
3. Type B, shall be utilized on street inlets without curb head, once surrounding surfaces are in place.
4. Type C, shall be utilized on street inlets with curb heads. Provide a 2 inch x 4 inch minimum, piece of wood and wrap and attach fabric to wood. Place wood blocking and fabric over inlet with wood straddling inlet opening a minimum of 8 inches in each direction. Secure 2 x 4 inch board to grate with wire or plastic ties. Verify and secure wood blocking to rest on inlet grate and that fabric covers remaining curb head opening. Wood blocking shall not block entire inlet curb opening.
5. Type D, shall be utilized in areas where other types of inlet protection are identified as incompatible with roadway and traffic conditions causing possible safety hazards when water ponding occurs at the inlet. Provide inlet protection as detailed on Drawings.
6. For all inlet protection devices ponding water to settle sediment is encouraged, however ponding shall not interfere with the flow of traffic, create a safety hazard, or cause property damage.

7. All inlet protection devices shall have provisions such as weep holes or emergency spillways to safely pass water if inlet protection device becomes clogged.
8. No gaps shall be left in the material used that would allow the flow of water to bypass the inlet protection device.

H. Dust Control on Construction Sites: (WDNR – CPS 1068)

1. Provide one of or a combination of one of the following dust control practices for the duration of the project or until site is fully vegetated or paved.
   a. Asphalt and petroleum-based products shall not be used for project dust control.
   b. Provide mulch or seed and mulch to protect exposed site soil from both wind and water erosion. Reference WDNR – CPS 1058 and 1059 specified previously in this section.
   c. Provide water applications until surface is wet and repeat as necessary. Water shall be applied so it does not cause runoff.
   d. Provide tilling of soil with chisel type plows on exposed soils. Tillage shall be utilized only on flat areas of the project site.
   e. Provide tackifiers and soil stabilizers, Type A – Products shall be selected from and installed at rates in accordance with WisDOT Erosion Control PAL.

3.2 MAINTENANCE

A. Inspect erosion control devices within 24 hours after each rainfall or daily during periods of prolonged rainfall.

B. Repair or replace damaged or defective materials or installation immediately.

C. Remove sediment deposits within 24 hours after each storm event or when deposits reach one-half height of fence or barrier, whichever occurs first.

D. Apply replacement bales or additional mulch, netting, or matting immediately to maintain suitable cover.

E. Where vegetative cover has been placed, inspect until vegetative cover is established and functioning as intended.

3.3 REMOVAL OF EROSION CONTROL DEVICES

A. Maintain erosion control measures disturbed earth has been paved or vegetated.

B. Remove erosion control devices prior to final inspection and acceptance of Project site by Owner.

C. Restore or replace areas disturbed or damaged by removal of erosion control devices to satisfaction of Engineer.

END OF SECTION

SECTION 321123
AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aggregate Materials.
   2. Sub-grade Preparation.
   3. Test Rolling Equipment and Procedures.
   4. Aggregate Installation Requirements.
   5. Base Course Schedule.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 310516 – Aggregates for Earthwork.
   3. Section 312213 - Rough Grading: Preparation of site for base course.
   4. Section 312317 – Site Excavation, Backfill, and Compaction.
   5. Section 321216 – Asphalt Paving: Binder and surface asphalt courses.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation
   1. Standard Specifications for Highway and Structure Construction, Current Edition. (WISDOT)

B. ASTM International (ASTM):
   1. ASTM D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft.-lbf/ft^3.
   2. ASTM D6938 – Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

PART 2 PRODUCTS

2.1 AGGREGATE MATERIALS

A. Aggregate Material: Type A1 or A2 as specified in Section 310516 – Aggregates for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrate is dry and has been inspected, and gradient and elevation are correct.

3.2 SUBGRADE PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and recompacting.

B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 TEST ROLLING SUBGRADE

A. Test rolling shall be used to verify stability and uniformity of subgrade. Perform this Work in presence of Engineer and Testing Agency.

B. Use test rolling equipment conforming to following description:
   1. Tandem axle, dual wheel dump truck.

2. Tire pressure shall be no less than 90 percent of manufacturer's recommended maximum inflation.
3. Minimum gross weight of loaded truck shall be 60,000 pounds.
4. Provide weigh slip to Engineer and Testing Agency.

C. Perform test rolling procedure as follows:
1. Operate equipment at a rate not to exceed 3 to 5 mph or a comfortable walking pace. Adjust speed to allow Engineer and Testing Agency to measure any deflections and areas of rutting.
2. Operate test rolling equipment in a pattern so that affected areas are loaded with at least one pass.
3. After test rolling, check subgrade for conformance to drawings, and correct any surface irregularities. Re-shape subgrade within tolerances specified.

D. Test Rolling Evaluation:
1. Rutting up to 1-inch is acceptable. Rutting in excess of 1-inch but not more than 6 inches, shall be considered a failure and requires reworking soil and compaction to required density.
2. Deflection (pumping) up to 1-inch is acceptable. Deflection in excess of 1-inch but not more than 2 inches shall be acceptable if there is not substantial cracking or lateral movement of soil.
3. Deflection in excess of 2 inches but not more than 6 inches shall be considered a failure, and requires reworking soil and compaction to required density.
4. Rutting and deflection in excess of 6 inches will require review and recommendation for corrective action by an approved Geotechnical Engineer.
5. After remedial work is performed, a final test roll shall be performed upon completion of work.
6. If remedial work is performed as directed, second test roll may be waived at discretion of Engineer and Testing Agency.

3.4 AGGREGATE INSTALLATION REQUIREMENTS

A. Spread aggregate over prepared substrate to a total compacted thickness as indicated on Drawings.

B. Place aggregate in maximum 7-inch loose lifts and compact to specified density.

C. Level and contour surfaces to elevations and gradients indicated.

D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.5 TOLERANCES

A. Section 310516 – Aggregates for Earthwork defines "A" designated base course materials.

B. Flatness: Maximum variation of 1/4-inch measured with 10-foot straight edge.

C. Scheduled Compacted Thickness: Within 1/4-inch.

D. Variation from Design Elevation: Within 1/4-inch.

3.6 FIELD QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Field inspection.

B. Perform compaction testing in accordance with ASTM D1557, ASTM D6938, and Section 310200 – General Requirements for Sitework.

C. Perform moisture content testing in accordance with ASTM D6938 and Section 310200 – General Requirements for Sitework.

D. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

E. Frequency of Tests: As determined by Engineer and Testing Agency.

3.7 BASE COURSE SCHEDULE

A. Section 310516 – Aggregates for Earthwork defines “A” designated base course materials.

B. Under Asphalt Pavement:
   1. Aggregate Type A1 or A2, compact to 95 percent modified Proctor density.

C. Under Concrete Pavement and Curb:
   1. Aggregate Type A1 or A2, compact to 95 percent modified Proctor density.

D. Under Concrete Sidewalk:
   1. Aggregate Type A1 or A2, compact to 95 percent modified Proctor density.

END OF SECTION

SECTION 321216
ASPHALT PAVING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Asphalt Paving Mix.
   2. Asphalt Materials.
   3. Aggregate Base Course.
   4. Tack Coat Preparation.
   5. Placing Asphalt Pavement - Two Course Installation.

B. Related Sections:
   1. Applicable provisions of Section 310200 - General Requirements for Sitework shall govern Work under this Section.
   2. Section 310516 – Aggregates for Earthwork: Product requirements for aggregate for placement by this section.
   3. Section 312213 - Rough Grading: Preparation of site for paving and base.
   4. Section 321123 - Aggregate Base Course: Compacted granular base for paving.

1.2 REFERENCES

A. State of Wisconsin Department of Transportation
   1. Standard Specifications for Highway and Structure Construction, Current Edition. (WISDOT)

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Product Data: Submit product information and mix design.

C. Certification: Provide Manufacturer's Certification Report that indicates Products and Materials meet or exceed all specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Wisconsin Department of Transportation Standards.

B. Mixing Plant: Conform to WISDOT Section 450.

C. Obtain materials from same source throughout.

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum five years experience.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Section 310200 – General Requirements for Sitework: Environmental conditions affecting products on site.

B. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or if surface is wet or frozen.

C. Install Work in accordance with WISDOT Section 450.

D. Place bitumen mixture when mixture temperature is not more than 15 degrees F below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.1 ASPHALT PAVING MIX

A. Use dry material to avoid foaming. Mix uniformly.

B. Provide Asphaltic Concrete Binder Course Mixtures as specified below:

1. Asphaltic Concrete Binder Course: WISDOT Section 460, Mix E-0.3, in accordance with Table 460-1, Aggregate Gradation Master Range, 12.5 mm, and Table 460-2, Mixture Requirements, PG 64-22.

C. Provide Asphaltic Concrete Surface Course Mixtures as specified below:

1. Asphaltic Concrete Surface Course: WISDOT Section 460, Type E-0.3, in accordance with Table 460-1, Aggregate Gradation Master Range, 9.5 mm, and Table 460-2, Mixture Requirements, PG 64-22.

D. Recycled Asphalt Pavement (RAP) shall not be used.

2.2 ASPHALT MATERIALS

A. Tack Coat: SS-1, SS-1h, CSS-1, or CSS-1h in accordance with:

1. WISDOT Section 455.

2.3 SOURCE QUALITY CONTROL AND TESTS

A. Section 310200 – General Requirements for Sitework: Testing, inspection and analysis requirements.

B. Submit proposed mix design for each mixture for review prior to beginning of Work.

C. Provide test samples in accordance with Section 310200 – General Requirements for Sitework.

D. Perform Asphaltic Concrete Testing in accordance with WISDOT Section 460.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 310200 – General Requirements for Sitework: Verification of existing conditions before starting work.

B. Verify compacted subgrade and aggregate base are acceptable and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

3.2 AGGREGATE BASE COURSE

A. Section 321123 - Aggregate Base Course for base course construction for Work of this section.

3.3 TACK COAT APPLICATION

A. Apply tack coat in accordance with WISDOT Section 455.

B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd.

C. Apply tack coat to contact surfaces of curbs, gutters, and other concrete surfaces.

D. Coat surfaces of manhole, catch basin, and utility frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.4 PLACING ASPHALT PAVEMENT - TWO COURSE INSTALLATION

A. Install asphalt pavement in accordance with WISDOT Section 450.

B. Place asphalt binder course within 24 hours of applying primer or tack coat.

C. Place binder course to thickness shown on Drawings.

D. Place surface course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing surface course, clean surface and apply tack coat before placing surface course.

E. Place surface course to thickness shown on Drawings.

F. Install utility grilles and frames in correct position and elevation prior to installation of pavement.

G. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.

H. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.5 TOLERANCES

A. Section 310200 – General Requirements for Sitework: Tolerances.

B. Flatness: Maximum variation of 1/8-inch measured with 10-foot straight edge.

C. Scheduled Compacted Thickness: Within 1/4-inch.

D. Variation from Indicated Elevation: Within 1/4-inch.

3.6 FIELD QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Field inspecting, testing, adjusting, and balancing.

B. Provide two 4-inch diameter disks, 2-1/2 inches high, each day that asphalt pavement is placed.

3.7 PROTECTION OF FINISHED WORK

A. Section 310200 – General Requirements for Sitework: Protecting finished work.

B. Immediately after placement, protect pavement from mechanical injury for 12 hours or until surface temperature is less than 140 degrees F, whichever occurs first.

END OF SECTION

SECTION 321313
CONCRETE PAVING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Materials and Installation requirements for exterior concrete components as follows;
      a. Sidewalks.
      b. Curb and combination curb and gutter.
      c. Handicap ramps.
      d. Aggregate base course.
   2. Exterior Concrete Design Requirements as follows;
      a. Concrete mix design.
      b. Reinforcement.
      c. Concrete curing and sealing.
      d. Jointing.
      e. Quality control and testing.
      f. Concrete placement and finishing.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 312213 - Rough Grading: Preparation of site for paving and base.
   3. Section 312317 – Site Excavation, Backfill, and Compaction: Compacted subbase for paving.
   4. Section 321123 - Aggregate Base Course: Compacted granular base for paving.
   5. Section 321216 - Asphalt Paving: Asphalt surface course.

1.2 REFERENCES

A. American Concrete Institute (ACI)
   1. ACI 224.3R, Joints in Concrete Construction, Chapter 6 – Pavements.
   2. ACI 301 – Structural Concrete.
   3. ACI 304 - Guide for Measuring, Mixing, Transporting and Placing Concrete.
   4. ACI 305 – Hot Weather Concreting.
   5. ACI 306 – Cold Weather Concreting.
   6. ACI 308 – Standard Practice for Curing Concrete.
   7. ACI 309 – Guide for Consolidation of Concrete.
   8. ACI 325 – Guide for Construction of Concrete Pavements and Concrete Bases.
   9. ACI 330 – Guide for Design and Construction of Concrete Parking Lots.
   10. ACI 330.1 – Specification for Unreinforced Concrete Parking Lots.
   11. ACI 347 – Guide to Formwork for Concrete.

B. ASTM International (ASTM)
   1. ASTM A615 - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   2. ASTM A775 - Specification for Epoxy-Coated Reinforcing Steel Bars.
   3. ASTM A884 - Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
   4. ASTM C31 – Practice for Making and Curing Concrete Test Specimens in the Field.
   5. ASTM C33 - Specification for Concrete Aggregates.
   6. ASTM C39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   7. ASTM C94 - Specification for Ready-Mixed Concrete.
   8. ASTM C143 – Test Method for Slump of Hydraulic-Cement Concrete.
   9. ASTM C150 - Specification for Portland Cement.
   10. ASTM C172 - Practice for Sampling Freshly Mixed Concrete.
   11. ASTM C231 – Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

12. ASTM C260 - Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
14. ASTM C494 - Specification for Chemical Admixtures for Concrete.
15. ASTM C618 - Specification for Fly Ash as Admixture for Concrete.
16. ASTM C920 – Specification for Elastomeric Joint Sealants.
17. ASTM C1193 - Guide for Use of Joint Sealants.
18. ASTM C1602 – Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
19. ASTM D1751 - Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction Nonextruding and Resilient Bituminous Types.

C. United States Access Board:
   1. ADA Accessibility Guidelines for Buildings and Facilities.(ADAAG)

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Submit proposed mix design of each class of concrete to Engineer not later than 10 days after Notice to Proceed or 15 days prior to the first concrete placement, whichever comes first.

C. Contractor shall submit a jointing plan for expansion, isolation, contraction and construction joints prior to placing any concrete.

D. Jointing plan shall include details for doweled joints indicating dowel bar size and length, dowel supports, and distance between dowels.

E. Jointing plan shall include details for tie bar joints indicating tie bar size and length, tie bar supports, and distance between tie bars.

F. Include sequence of concrete placement indicating location of construction joints.

G. Jointing plan shall meet the requirements of the referenced ACI Standards.

H. Failure to submit a jointing plan to the Engineer prior to the placement of any concrete will result in the rejection of concrete placed prior to Engineer review and approval of jointing plan.

I. Product Data: Submit data on joint filler, reinforcement, admixtures, and curing compounds.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with specified ACI requirements.

B. Maintain one copy of each document on site.

C. Obtain cementitious materials from same source throughout.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Conform to requirements of Section 310200 – General Requirements for Sitework.

B. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 PRODUCTS

2.1 FORM MATERIALS

A. Form Materials: Conform to ACI 301 and 347.

2.2 REINFORCEMENT

A. Epoxy-Coated Joint Dowel Bars: ASTM A775; with ASTM A615, Grade 60, smooth steel bars. Cut bars true to length with ends flush and free of burrs.

B. Epoxy Repair Coating: Liquid, two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

C. Epoxy-Coated Tie Bars: ASTM A615, Grade 60, deformed billet steel bars; with ASTM A775 epoxy-coated finish.

D. Reinforcement Supports:
   1. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, and dowels in place.
   2. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete.
      a. Provide wire bar supports with plates or horizontal runners where base material will not support chair legs.
      b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.

2.3 CONCRETE MATERIALS

A. Cement: ASTM C150 Normal – Type 1, gray color.

B. Fine and Coarse Mix Aggregates: ASTM C33.

C. Water: ASTM C1602, potable, not detrimental to concrete.

D. Air Entrainment: ASTM C260.

E. Flyash: ASTM C618. Class C.

2.4 CHEMICAL ADMIXTURES

A. Chemical admixtures shall be in accordance with ASTM C494.

B. Concrete may contain Type A Water-reducing admixture.

C. Admixtures are to be used in accordance with manufacturer's recommendations.

D. Chemical admixtures containing chlorides, sulfides, or nitrides are not permitted.

E. A single manufacturer shall supply permitted admixtures.

F. Admixture manufacturers are to be approved in writing by Engineer prior to use.

2.5 ACCESSORIES

A. Joint Filler: ASTM D1751, Bituminous fiber, 1/2-inch wide by depth of concrete less 1/8-inch.

B. Form Release Agent: Colorless material which will not stain concrete, absorb moisture or impair natural bonding or color characteristics of coating, intended for use on concrete.

2.6 CURING AND TREATMENT MATERIALS

A. Water: Potable and clean.

B. Membrane Curing Compound, ASTM C309, Type I, Class A, free of oil, wax, or grease.

C. Concrete Pavement Cold-Applied Joint Sealants:
   1. Multi-Component Sealant for Concrete: Pourable, chemically curing elastomeric formulation complying with the following requirements for formulation and with ASTM C920 for type, grade, class, and uses indicated:
      a. Urethane Formulation: Type M, Grade P: Class 12-1/2; Uses T, M, and as applicable to joint substrates indicated.
   2. Products: Subject to compliance with requirements, provide the following:
      a. Multi-Component Sealant for Concrete:
         1) Vulkem; Tremco, Inc.
         2) GARDOX.
         3) Urexpan.

D. Concrete Pavement Hot-Applied Joint Sealants:
   1. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D7116.
   2. Products: Subject to compliance with standard requirements, provide one of the following:

a. Elastomeric Sealant for Concrete:
   1) Superseal; Crafco, Inc.
   2) HI-SPEC; W.R. Meadows, Inc.
   3) POLY-JET LOX; W. R. Meadows, Inc.

2.7 CONCRETE MIX

A. Mix concrete in accordance with ASTM C94.

B. Schedule of Mixes:

Class	Name	Maximum Aggregate Size (inch)	Maximum Slump** (inch)	Minimum Cement Sacks/cu.yd.	Minimum Compressive Strength (psi/28 days)	Maximum Water Cement Ratio
9*	Exterior Walks, Curbs, gutters Drives, Ramps	3/4	3	6.25	4000	0.45

* Air Entrained Concrete Mix. Normal Acceptable range of air content is 5-7 percent.
** Slump Tolerances Maximum slump of 3-inch plus 1-inch, minus 1/2-inch.

C. Prepare and submit concrete mix designs in accordance with Section 310200 – General Requirements for Sitework, and include as part of cost of this Work.

D. A qualified agency acceptable to Engineer shall prepare mix designs. Submit electronic copies of mix designs for Engineer's review prior to placing any concrete.

E. Mix design shall indicate brands, types, and quantities of admixtures included, compressive strength, slump, sieve analysis for fine and coarse aggregate, quantities of all ingredients, type and brand of cement, source of aggregate, and whether fine aggregate is natural or manufactured.

F. Use accelerating admixtures in cold weather only when approved by Engineer in writing. Use of admixtures will not relax cold weather placement requirements.

G. Use calcium chloride only when approved by Engineer in writing.

H. Use set retarding admixtures during hot weather only when approved by Engineer in writing.

2.8 SOURCE QUALITY CONTROL AND TESTS

A. Section 310200 – General Requirements for Sitework: Provide mix design for Class 9 concrete.

B. Submit proposed mix design to appointed firm for review prior to commencement of Work.

C. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

D. Test samples in accordance with ACI 301.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 310200 – General Requirements for Sitework: Coordination and project conditions.

B. Verify compacted subgrade and granular base are acceptable and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

3.2 SUBBASE

A. Section 321123 - Aggregate Base Course, forms base construction for Work of this section.

3.3 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Coat surfaces of manhole, catch basin, inlet, and utility frames with oil to prevent bond with concrete pavement.

C. Notify Engineer minimum 24 hours prior to commencing concrete operations.

3.4 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 PLACING REINFORCEMENT

A. Place reinforcement as indicated on approved jointing plan.

B. Interrupt reinforcement at control isolation and expansion joints.

C. Position the reinforcement on approved chairs securely fastened to the subgrade prior to concrete placement.

D. Mechanically screed concrete after the steel has been placed.

E. Regardless of placement procedure, ensure the reinforcing steel is free from coatings which could impair bond between the steel and concrete, and indicate laps in the reinforcement as indicated.

F. In lieu of the above, automatic reinforcement depressing attachments may be used to position the reinforcement provided the entire operation is approved by Engineer.

G. Regardless of the equipment or procedures used for installing reinforcement, ensure that the entire depth of concrete is adequately consolidated by the mechanical screeding process.

H. The method used in installing and holding dowels in position must ensure that the error in alignment of any dowel from its required horizontal and vertical alignment after the pavement has been completed will not be greater than 1/8 in. per ft.

I. Horizontal spacing of dowels must be within a tolerance of plus or minus 5/8 inch.

J. Do not place dowels and tie bars closer than 0.6 times the dowel bar or tie bar length to the planned joint line.

K. If the last regularly spaced dowel or tie bar is closer than that dimension, it must be moved away from the joint to a location 0.6 times the dowel bar or tie bar length.

L. For contraction joints:
   1. Hold dowels and tie bars in longitudinal and transverse contraction joints within the paving area securely in place by means of rigid metal frames or basket assemblies of an approved type.
   2. Hold the basket assemblies securely in the proper location by means of pins or anchors.

M. For construction joints in fixed form paving applications;
   1. Install dowels and tie bars using the bonded-in-place method. Do not install by removing and replacing in preformed holes.
   2. Prepare dowels and tie bars and place across joints where indicated on approved jointing plan, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms.

N. For construction joints in fixed hardened concrete applications;
   1. Install dowels in hardened concrete by bonding the dowels into holes drilled into the hardened concrete.

2. Drill holes approximately 1/8 inch greater in diameter than the dowels into the hardened concrete.
3. Repair any damage to the concrete face during drilling as directed.
4. Bond dowels in the drilled holes using epoxy resin.
5. Inject epoxy resin at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Do not apply by buttering the dowel.
6. Hold the dowels in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel.

O. Wipe clean the portion of each dowel intended to move within the concrete or expansion cap and coat with a thin, even film of lubricating oil before the concrete is placed.

3.6 PLACING CONCRETE

A. Place concrete in accordance with specified ACI Requirements.

B. Concrete may be placed using slip form technique.

C. Ensure reinforcement, inserts, embedded parts, formed joints and utility structures are not disturbed during concrete placement.

D. Place concrete continuously over full width of panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.7 JOINTS

A. Place contraction joints as follows for identified entities:
1. Curb and Gutter: 10 feet.
2. Sidewalks: As indicated on approved Jointing Plan.
3. Area Paving: As indicated on approved Jointing Plan.

B. Place expansion joints using joint filler as follows for identified entities:
1. Curb and Gutter: 300 feet.
2. Sidewalks: As indicated on approved Jointing Plan.
3. Area Paving: As indicated on approved Jointing Plan

C. Align curb, gutter, and sidewalk joints.

D. Recess top of joint filler 1/8-inch for sealant placement.

E. Provide keyed joints as indicated.

F. Jointing shall be performed by hand tools. Jointing tools and equipment must provide minimum joint depth as specified by ACI requirements.

3.8 FINISHING

A. Sidewalk Paving: Broom finish. Edge sidewalk to 1/2-inch radius. Trowel joint edges.

B. Curbs and Gutters: Broom finish.

C. Direction of Texturing: Transverse to pavement direction.

D. Place curing compound on exposed concrete surfaces immediately after finishing.

3.9 JOINT SEALING

A. Separate pavement from vertical surfaces with 1/2-inch thick joint filler.

B. Place joint filler in pavement pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

C. Extend joint filler from bottom of pavement to within 1/8-inch of finished surface.

D. Comply with joint sealant manufacturer's written installation instructions applicable to products and applications indicated, unless requirements that are more stringent apply.

E. Comply with recommendations of ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

F. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of backer materials.
   2. Do not stretch, twist, puncture, or tear backer materials.
   3. Remove absorbent backer materials that become wet before sealant application and replace them with dry materials.

G. Install sealants by the following techniques at same time backer material is installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses provided for each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

H. Tooling of Non-Sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below forming smooth, uniform beads; eliminating air pockets; and ensuring contact and adhesion of sealant with sides of joint.
   1. Remove excess sealants from surfaces adjacent to joint.
   2. Use tooling agents approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

I. Provide joint sealant configuration complying with sealant manufacturer requirements and of depth and at locations indicated.

3.10 TOLERANCES

A. Section 310200 – General Requirements for Sitework: Tolerances.

B. Maximum Variation of Surface Flatness: 1/4-inch in 10 feet.

C. Maximum Variation from True Position: 1/4-inch.

3.11 FIELD QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Testing and inspection services.

B. Section 310200 – General Requirements for Sitework: Testing, adjusting, and balancing.

C. Concrete testing shall be paid for by Contractor.

D. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.

E. Take one additional test cylinder during cold weather and cure on site under same conditions as concrete it represents.

F. Take one slump test for each set of test cylinders taken.

G. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian traffic over pavement for 2 days minimum after finishing and vehicular traffic over pavement for 7 days minimum after finishing.

END OF SECTION

SECTION 321316
DECORATIVE CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Exterior and interior cement concrete pavement with imprinted or textured surface patterns achieved by specified proprietary materials and procedures:
   1. Release agent.
   2. Stamped concrete tools.

B. Related Sections:
   1. Section 033000 – Cast-In-Place Concrete: Concrete materials and reinforcement, and including impressed accessibility texture.
   2. Section 079200 – Joint Sealants: Elastomeric joint filler/sealer (coordinate colors).
   3. Appendix A - Photo References

C. Coordination:
   1. Notify Architect 14 days prior to scheduled performance of work.
   2. Conduct a coordination meeting to assure that other trades do not interfere with work.
   3. Coordinate work with Owner 14 days prior to commencement of work.

1.3 SUBMITTALS

A. General: Submit in accordance with Section 013300.

B. Product Data:
   1. For the following:
      a. Each type of finish material utilized.
      b. Joint backer and sealant materials.
      c. Concrete mix designs and reinforcing, coordinate with Section 033000.

C. Shop Drawings:
   1. Submit dimensioned paving plans indicating layout of stamped patterns, control joints, and expansion joints. Show specimen hand-carved jointing details, including joints within field of each pattern, and at perimeter of stamped pattern concrete pavement; straight joints are not acceptable.

D. Samples
   1. Submit 48- by 48-inch samples to illustrate quality of finish, color and texture of exposed surface, based on Appendix A. Samples to remain on site through duration of Work.

E. Manufacturers Qualifications
   1. Certifications specified in Quality Assurance article.
   2. Material certificates, signed by material producer and Contractor, certifying that materials comply with or exceed specified requirements.
   3. Qualification Data: Installer's qualification data including approval by system manufacturer.
   4. Manufacturer's written installation instructions.

F. Warranty

1. Provide warranty for completed installation signed by manufacturer, applicator and Contractor warranting against defects of materials and workmanship for period of 2 years from date of Substantial Completion.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm licensed by stamped pattern system manufacturer, with a record of successful in-service applications of the type specified over a period of at least 5 years, and employing experienced factory-trained workers.

B. Single Source Responsibility: Obtain each type of product or system from a single source and by one manufacturer for each different product.

C. Field Supervision: Ensure that work under this Section is supervised by an authorized representative of the system manufacturer.

D. Pre-Installation Conference: Prior to installing stamped pattern concrete paving, meet at Project site with Installer, Architect, Owner's Representative, and other persons whose work affects, or is affected by, work under this Section. Review pattern and jointing layout.

1.

PART 3 - PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement Concrete: Materials and mixes per Section 033000, except as indicated otherwise.

B. Reinforcement: Size as indicated on Drawings.
1. Welded Wire Fabric: ASTM A 185, plain wire, furnished in flat sheets.
2. Reinforcing Bars: ASTM A 615, Grade 60, deformed steel bars.
3. Load Transmission Devices: Smooth, steel dowel bars conforming to ASTM A 615, Grade 60. When indicated on Drawings, encase one end of dowel bar in approved cap having inside diameter 1/16 inch greater than diameter of dowel bar.

C. Expansion Joint Materials: Coordinate color selections with Architect.
1. Joint Filler: Pre-formed nonextruding resilient material; ASTM D1752, Type I, 5/8 inch wide by depth required to bring top surface within 1/2 inch of slab surface.
2. Joint Sealer: Self-leveling polyurethane, refer to Section 079200.

D. Specialty Materials - Source: Provide following specialty products manufactured or supplied by L.M. Scofield Company, Los Angeles CA. Substitutions may be considered.
1. Release Agent: Standard release agent that will not adversely affect staining of concrete pavement and as recommended by system manufacturer.
2. Stamped Concrete Tools: Lithotex Pavecrafters system by L.M. Scofield Company, or equalivalent, using mat-type embossing skins with texture to match photo references.

E. Special Imprints: Zoo will provide additional imprinting materials, such as animal footprints, to Contractor. Mulch, pea gravel, leaves, and additional recommended embossing pads shall be provided by Contractor.

F. Custom Embossed Imprints: Contractor to provide custom pattern as indicated on the Drawings.

G. Sealer: Refer to Section 071900 - Water Repellents
1. Film forming surface sealers will not be accepted. Any non-penetrating sealers will be removed and replaced at no cost to the Owner with no exceptions.

2.2 CONCRETE MIX

A. Use air entrainment admixture in concrete mixes.

B. Do not permit use of calcium chloride or any admixture containing calcium chloride.

C. Do not permit use of cement substitutes, waterproofing admixtures, or superplasticizers without written instructions by manufacturer of color-conditioning materials.

PART 4 - PART 3 – EXECUTION

3.1 SUBSTRATE PREPARATION

A. Examine substrates to receive stamped pattern concrete pavement and ensure that conditions comply with recommendations and requirements of the system manufacturer.

B. Prepare crusher-run or sand bed substrate as specified for concrete slabs on grade.

C. When slab is placed over existing construction, clean of loose material and prepare surface according to recommendations of ACI and as indicated.

3.2 CONCRETE PLACEMENT

A. Formwork: Install formwork according to Section 033000 and as indicated on Drawings. Secure rigidly in place to form uniform straight or curved lines as indicated. Set to provide pavement 4 inches thick unless otherwise indicated.

B. Reinforcement: Place reinforcement as indicated, positioning it at approximate center of slab.

C. Place and screed concrete to required grade. Float, using standard concrete practices. Provide transitions and slopes according to ADA requirements.

D. If the limit of removal of existing concrete or asphaltic pavement does not fall on existing joint, saw cut existing pavement minimum of 2 inches deep to provide straight, smooth joint surface without chipping, spalling or cracks.

3.3 IMPRINTING

A. When concrete is firm enough to support weight of applicator without low areas or birdbaths forming and is at the correct state of hardening for imprinting, hand-broadcast Release Agent evenly across surface according to manufacturer’s specifications.

B. Place first embossing skin as close as possible to where concrete was first deposited. Imprint surface according to manufacturer’s instructions. Place next skin so that it overlaps outer edge of first skin. Continue to place skins and imprint surface overlapping edges of previous skins.

C. When all embossing skins are placed, pull back edge of second skin and remove edge of the first skin and place it on top. Take care to ensure embossing skins do not leave edge-of-pad lines in pavement; when embossing leaves, ensure that no roller marks are left in pavement. Determine that proper imprint has been made; apply additional special imprints according to Owner’s instructions. If areas are deficient, carefully replace skin and press or use tamper to repair the design. Continue in same manner, using lifted embossing skins for other areas of the design.

D. Curing: After imprinting, cure surface until it has gained sufficient strength not to be damaged, a minimum of 7 to 10 days. Cure surface according to manufacturer’s recommendations and complying with Article 3.8 in Section 033000.

E. Release Agent Removal: Remove excess release agent by brooming or vacuuming imprinted concrete surface after it is hard enough to walk on without marring. After imprinted concrete has been cured 7-10 days, remove remaining unembedded release agent by a high-pressure detergent wash, followed by a thorough rinsing. Prior to washing and rinsing entire area, test an adequate area to ensure that concrete is strong enough to resist scaling and other damage.

F. Stain: Contractor shall clean and hose off walks immediately prior to staining. Apply sealer promptly after staining according to manufacturer's instructions.

G. Sealing: As soon as possible after antiquing release has been removed and moisture content of the concrete is low enough that alkali and other salts do not become trapped beneath the sealer (normally a minimum of 14 to 28 days after placement), apply two coats of sealer per Section 071900.

3.4 JOINTS

A. Expansion Joints: Construct expansion joints where indicated on Drawings and at other pre-determined locations. Construct joints full depth of pavement and of nominal half inch in widths necessary to accommodate thermal movement that might reasonably be anticipated.

B. Hand trowel joints in irregular shapes to resemble cracks that would occur naturally in each type of stamped material representation. Avoid straight joints in irregular material representations.

C. Seal joints only when surface and joints are dry, ambient temperature is above 50 degrees F and less than 85 degrees F, and weather is not foggy or rainy.

3.5 PROTECTION

A. Protect imprinted concrete surfaces from damage by other trades until end of construction.

B. Repair and cure damaged finished surfaces of imprinted concrete, matching color, texture, and uniformity of surrounding surfaces. Remove and replace concrete that cannot be repaired to Architect's approval.

END OF SECTION

SECTION 323113
MESH FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:
   1. Section 129353 – Exhibit Furnishings.
   2. Section 323129 – Wood Fences and Gates.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Fence Height: Varies per Drawings.
   2. Provide fencing and components complying with FS RR-F-191K/GEN.

1.3 SUBMITTALS

A. General: Submit in accordance with Division 1.

B. Product Data:
   1. For the following:
      a. Each type of chain link fabric.
      b. Each type of frame component, connection hardware, and tension hardware.
      c. Accessories and anchorage devices.
      d. Each type of stainless steel mesh.
      e. Each type of galvanized steel cable.

C. Shop Drawings:
   1. Complete shop drawings for the fabrication and installation of chain link fencing and gate components and gates, including plans, sections and details. Indicate layout, spacing of components, gate openings, accessories, fitting and anchorage. Detail interfaces with the work of other trades, including required clearances and connections.

D. Samples:
   1. N/A.

E. Manufacturers Qualifications:
   1. Certifications specified in Quality Assurance article.
   2. Documentation of manufacturer and installers qualifications, including verification of a minimum of 5 years experience with similar types of Work.
   3. Manufacturer's written installation instructions.

F. Warranty:
   1. Manufacturer shall offer a written 2 year limited warranty on all products and associated hardware, against defects in materials and workmanship.
   2. Installer shall offer a written 2 year limited warranty on workmanship against defects in installation and workmanship.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Provide chain link fences and gates as complete units controlled by single source including necessary accessories, fittings, and fastenings.

B. Manufacturer Qualifications: Minimum 3 years experience in production of commercial and industrial chain link fencing.

C. Installer Qualifications: Minimum 3 years experience in installation of commercial and industrial chain link fencing.

D. Animal Safety: THIS IS A MATTER OF LIFE AND DEATH FOR CERTAIN ANIMALS. Do not allow cut wire ends or pieces of fence fabric to fall onto unprotected ground. Account for all debris and remove from the site completely. Scan the ground around all fencing with a metal detector and remove any and all buried metal pieces.

E. Certifications: Manufacturer's certification that products furnished for Project meet or exceed specified requirements.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with requirements of Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

B. Galvanized Steel Fencing and Fabric:
   1. Allied Tube and Conduit Corporation, Harvey, IL.
   2. American Fence Corporation, Phoenix, AZ.
   3. Anchor Fence, Inc., Baltimore, MD.
   4. USX Corporation, Cyclone Fence, Chicago, IL.

C. Cable mesh:
   1. A thru Z Consulting, Tucson, AZ.
   2. Nets Unlimited, Cave Creek, AZ.
   3. Triumph Gate Ltd, Hong Kong.

2.2 MATERIALS

A. Hoofstock Chain Link Mesh Fence:
   1. Gauge: Hoofstock Exhibits: 11/2” x 9GA black vinyl coated.
   2. Size: 11/2” x 11/2” inch mesh, top and bottom selvages knuckled.
   3. Furnish one-piece fabric widths for fencing up to 12'-0" high.
   4. Fabric Finish: black vinyl coated galvanized, ASTM A392, Class II, with not less than 2.0 oz. zinc/square feet of surface.

B. Hoofstock Cable Mesh Fence:
   1. Gauge: 2”x2”x1/8” ss cable mesh with black oxide finish.
   2. Size: 2” x 2” inch mesh.
   3. Furnish one-piece fabric widths for fencing up to 12'-0" high.
   4. Fabric Finish: Black oxidized stainless steel.
   5. Horizontal cable per drawings: 5/8” galv steel cable per structural; mesh laced to cable with 1/8” ss steel cable with black oxide finish.
   6. Post: Epoxy primed and painted steel post; size per structural.

C. Elephant Cable Fence:
   1. Post: back steel pipe with cap; size per structural.
   2. Cables: Galvanized steel size per structural.
   3. PVC sleeve insulator with nuts installed in hole in pipe.
   4. Galvanized steel closed tube turnbuckles; see structural for size.
   5. Posts to be painted with epoxy primer and paint; color to be selected from manufacturer’s standard color palette by Architect.

D. Visitor Mesh Barrier:
   1. Mesh: 2”x4” black vinyl coated welded wire mesh.
   2. Height: 42” height top and bottom selvages knuckled.
   3. Wire ties: 11 gauge galvanized steel, color to match fence fabric.
   4. Posts: 2.375 inch o.d. steel pipe, 5.02 lbs./lin. ft. black powder coating.

E. Framework:

1. Galvanized steel, ASTM A53 or A123, Schedule 40 steel pipe, A569 for hot-rolled sections with minimum yield strength of 45 ksi with not less than 1.8 ounce zinc/square feet of surface.
2. Provide one-piece sections without joints.
3. Size posts and rails to comply with ASTM F669.
4. Finish: Black powder coated prior to installation.

F. Hardware and Accessories:

1. Finish: Galvanized, ASTM A123 or A153.
2. Provide fittings complying with ASTM F626.
3. Wire ties: 11 gauge galvanized steel, military ties on black bear fence, color to match fence fabric.

2.3 CHAINLINK FENCE COMPONENTS

A. End, Corner, and Pull Posts: Minimum sizes and weights as follows:

1. Cable Mesh Exhibit Fence: Per structural Drawings.
2. Hoofstock chainlink fence: 2.375 inch o.d. steel pipe, 5.02 lbs./lin. ft.

B. Line Posts: Space 10'-0" on centers maximum unless otherwise indicated of following minimum sizes and weights:

1. Cable mesh exhibit fence: Per structural Drawings.
2. Hoofstock chainlink fence: 2.375 inch o.d. steel pipe, 5.02 lbs./lin. ft.

C. Gate Posts: 3.375 inch o.d. pipe posts for supporting single gate leaf or one leaf of double gate installation up to 6'-0" width; 4.0 inch o.d. pipe post for gate over 6'-0", up to 13'-0" in width.

D. Top Rail:

1. Manufacturer's longest lengths, 18'-0" minimum, with expansion type couplings for each joint.
2. Provide means for attaching top rail securely to each gate corner, pull and end post.
3. Hoofstock chainlink Fence: 2.375 inch o.d. steel pipe, 5.02 lbs./lin. ft.

E. Center Rails:

1. Same size as top rail; sized to fit between posts.
2. Provide necessary fittings.
3. Use on fences per drawings.

F. Bottom Rail

1. Cable mesh exhibit fence; ¾" galv steel cable.
2. Hoofstock chainlink fence: 2.375 inch o.d. steel pipe, 5.02 lbs./lin. ft.

G. Post Brace Assembly:

1. Manufacturer's standard adjustable brace at end and gate posts and at both sides of corner and pull posts.
2. Locate horizontal braces at mid height of fabric.
3. Use same material as top rail for brace and truss to line posts with 0.375 inch diameter rod and adjustable tightener.

H. Post Tops:

1. Weathertight closure cap for tubular posts, one cap for each post.
2. Furnish caps with openings to permit passage of top rail.

I. Stretcher Bar Bands:

1. Space bands 15 inches on centers maximum to secure stretcher bars to end, corner, pull and gate posts.
2. Form bands from flat or beveled steel, 3/4 inch minimum width and 0.078 inch thick after galvanizing for posts 4 inches in diameter or less; 7/8 inch minimum width and 0.108 inch thick for posts over 4 inches in diameter.

J. Swing Gates:

1. Fabricate swing gates to comply with ASTM F900, with perimeter frames sized to match line posts.
2. Metal and finish to match fabric.

3. Provide horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories.
4. Space frame members on 8'-0" centers maximum.
5. Assemble gate frames by welding or with special fittings and rivets for rigid connections providing security against removal or breakage of connections.
6. Use same fabric as for fence.
7. Install fabric with stretcher bars at vertical edges.
8. Bars may also be used at top and bottom edges.
9. Attach stretcher bars to gate frame at 15 inches on centers maximum.
10. Attach hardware to provide security against removal or breakage.
11. Install diagonal cross-bracing consisting of 3/8 inch diameter adjustable length truss rods on gates to ensure frame rigidity without sag or twist for gates over 10'-0" high without horizontal brace.

K. Swing Gate Hardware: Provide hardware and accessories, galvanized per ASTM A153, as follows:
1. Hinges:
   a. Hoofstock fence - Weldable barrel hinge - Basis of design: GH-207 by Hoover Fence, Co.
2. Latches:
   a. Hoofstock fence - Door latch with drop bar - Basis of design: 0125.00015 Latch by Richards-Wilcox, Inc.
3. Cane Bolts:
   a. Hoofstock fence - Drop solid cane bolt per drawings - Basis of design: 0524.00021 Cane Bolt by Richards-Wilcox, Inc. with mushroom head slot.

L. Concrete:
1. Provide concrete consisting of portland cement complying with ASTM C150, aggregates meeting ASTM C33, and clean water.
2. Provide ready-mix concrete complying with ASTM C94, with minimum 28-day compressive strength of 2500 psi using at least four sacks of cement per yd^3, 1 inch maximum size aggregate, maximum 3 inch slump and 2 to 4 percent entrained air.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with Division 1.

3.2 INSTALLATION

A. Install in accordance with Division 01 and approved shop drawings.

B. Install framework, fabric, accessories, and gates in accordance with manufacturer's instructions and ASTM F567.

C. Hoofstock fence: attach rails with standard chainlink fittings.

D. Excavation:
1. Drill holes for posts of diameters and spacings indicated in firm, undisturbed or compacted soil in accordance with manufacturer's instructions.
2. Excavate hole depths approximately 3 inches lower than post bottom with bottom of posts set not less than 36 inches below finish grade surface.
3. Excavate hole to minimum of 4 times largest cross-section of post.

E. Setting Posts:
1. Center and align posts in holes 3 inches above bottom of excavation.
2. Place concrete around posts and vibrate or tamp for consolidation.
3. Check each post for vertical and top alignment and hold in position during placement and finishing operations.
4. Terminate concrete 2 inches above finished grade and slope to of concrete for water runoff.

F. Top Rails: Run rail continuously through post caps. Provide expansion couplings as recommended by fencing manufacturer.

G. Center Rails: Provide center rails for fences 6’-0" high and over. Install in one piece between posts and flush with posts on fabric side.

H. Brace Assemblies:
   1. Install braces so posts are plumb when diagonal rod is under proper tension.
   2. Brace each gate and corner post to adjacent line post with horizontal center brace rail.
   3. Install brace rail in bay adjacent to end and gate posts.

I. Tension Wire:
   1. Install tension wires before stretching fabric and tie to each post with not less than 6 gage galvanized wire.
   2. Fasten fabric to tension wire using 11 gage galvanized steel hog rings spaced 24 inches on centers maximum.

J. Fabric:
   1. Allow not greater than 1 inch between finish grade and bottom selvage.
   2. Pull fabric taut and tie to posts, rails and tension wires.
   3. Install fabric on security side of fence and anchor to framework so that fabric remains in tension after pulling force is released.
   4. Install fabric on animal side of fence and anchor to framework so that there are no rough edges, and fabric remains in tension after pulling force is released.

K. Stretcher Bars:
   1. Thread through or clamp to fabric 4 inches on centers and secure to posts with metal bands spaced 15 inches on centers maximum.
   2. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

L. Privacy Slats: Install slats in vertical direction with Top Lock to securely lock in place where shown on drawings.

M. Gates:
   1. Install gates plumb, level and secure for full opening without interference.
   2. Install ground set items in concrete as recommended by fence manufacturer.
   3. Adjust hardware for smooth operation and lubricate where necessary.

N. Tie Wires:
   1. Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns.
   2. Bend wire to minimize hazard to persons or clothing.
   3. Tie fabric to line posts with wire ties spaced 12 inches on centers maximum.
   4. Tie fabric to rails and braces with wire ties spaced 24 inches on centers maximum.
   5. Tie fabric to tension wire with hog rings spaced 24 inches on centers maximum.
   6. Manufacturer's standard procedure will be accepted if of equal strength and durability.
   7. Do not cut wire ties or fence fabric over unprotected ground and remove all debris and wire from site completely.

O. Fasteners:
   1. Install nuts for tension bands and hardware bolts on side of fence opposite fabric side.
   2. Peen ends of bolts or score threads to prevent removal of nuts.

P. Scan ground surface with metal detector and remove any buried metal debris.

3.3 HARDWARE SETS

(next page)

SET B			**Single Leaf**
2	Hinges	CL-AHP-35	Hoover Fence
1	Latch Assembly	CL-FL-4	Hoover Fence
SET C			**Double Leaf**
4	Hinges	CL-AHP-35	Hoover Fence
1	Latch Assembly	CL-FL-4	Hoover Fence
2	Cane Bolts	0524.00021 Cane Bolt	Richards-Wilcox
SET D			**Double Leaf**
6	Hinges	GH-207	Hoover Fence
1	Latch Assembly	0125.00015 Latch	Richards-Wilcox
2	Cane Bolts	0524.00023 Cane Bolt	Richards-Wilcox
2	Supplemental Latches	UL-102Z	Hoover Fence

END OF SECTION

SECTION 323129
WOOD FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes but is not limited to the following:
   1. Supply materials for and construct and install wood fences, railings, and gates of basic types described on the Drawings.
   2. Furnish labor, materials, equipment and everything else needed to complete the work described by the Drawings and these Specifications.

B. Related Sections:
   1. Section 129353 – Exhibit Furnishings.
   2. Section 3323129 – Mesh Fences and Gates.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Fence Height: Varies per Drawings.
   2. Post Spacing: As indicated on Drawings.
   3. View Railing Height: 42” minimum per Drawings.
   4. Mesh Barrier Height: 42” minimum per Drawings.

B. Structural Requirements: Handrails: Capable of withstanding the following loads applied as indicated
   1. Concentrated load of 200 pounds applied at any point in any direction.
   2. Uniform load of 50 pounds per linear foot applied in any direction.
   3. Concentrated and uniform loads above need not be applied simultaneously.
   4. Infill area such as intermediate rails, pickets, and mesh panels capable of withstanding horizontal concentrated load of 200 pounds applied on 1 square foot and any point.

1.3 PERFORMANCE REQUIREMENTS

A. Fence posts shall be located with dimension tolerances as follows:
   1. Deviation from designated location (if any): ± 3”.
   2. Deviation from straight lines or even curves: ± 1”.
   3. Misalignment from plumb: 3/8” in 4’.

B. Standard for Materials:
   1. Metals shall conform to ASTM standards as specified in Section 055000.
   2. Finish Lumber:
      a. Moisture Content: 19 percent or less.
      b. Quality Standards: Western Lumber Grading Rules, WWPA.
      c. Species and Quality: Western red cedar, MG, grade A.

1.4 SUBMITTALS

A. General: Submit in accordance with Section 013300.

B. Product Data:
   1. For the following:
      a. Species/performance data for all finish wood fencing products.
      b. Each type of mesh fabric.
      c. Accessories and anchorage devices.

C. Shop Drawings:

1. Complete shop drawings for the fabrication and installation of wood fencing components and gates, including plans, sections and details. Detail interfaces with the work of other trades, including required clearances and connections.

D. Samples:
   1. Provide 12" samples of each type of finish material for wood fences and gates.
   2. Provide samples for cables, ropes, pulley systems, and other hardware required for remotely operated gates.
   3. Provide samples of cedar posts, eucalyptus pickets and railings as indicated on the Drawings.

E. Manufacturers Qualifications:
   1. Certifications specified in Quality Assurance article.
   2. Documentation of manufacturer and installers qualifications, including verification of a minimum of 5 years experience with similar types of Work.

F. Warranty:
   1. Manufacturer shall offer a written 2 year limited warranty on all products and associated hardware, against defects in materials and workmanship.
   2. Installer shall offer a written 2 year limited warranty on workmanship against defects in installation and workmanship.

1.5 QUALITY ASSURANCE

A. Qualifications of Subcontractor:
   1. Fabricate and finish fencing components in a shop qualified in the construction of Architectural Grade millwork.
   2. Installation shall be accomplished by tradesmen skilled in the necessary crafts, including, but not limited to; surveying, concrete placement, metal trades, rigging and wire rope fabrication.

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with requirements of Section 016000.

B. Transportation and Storage:
   1. For materials all materials, including shop-finished as required herein provide protective wrappings and crating as necessary during shipping & handling to maintain integrity and unblemished finish.

1.7 ANIMAL SAFETY

A. Do not cut wire ends or pieces of wire fabric on the ground. Account for all debris and remove from the site completely. THIS IS A MATTER OF LIFE AND DEATH FOR CERTAIN OF THE ANIMALS.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wood Framing: Per Section 062000 Finish Carpentry, ACQ pressure treated, non-incised.

B. Wood Finish: ACQ Western red cedar or approved equal, 5/4"x6" rough-sawn or as indicated in Drawings.

C. ACQ hardware requirement: All hardware in contact with ACQ treated wood to be hot-dipped galvanized.

D. Eucalyptus poles and rails: As provided by Safari Thatch, Ft Lauderdale, FL 954-564-0059.

E. Cedar wood posts: As provided by Aker Woods Company, Piedmont, SD 605-786-1127.

2.2 COMPONENTS

A. Wood Gate & Viewing rails:
   1. Boards: Western red cedar.

2. Board stain (semi-translucent): Per Section 099000.
3. Carriage bolts: Stainless steel.
4. Washers and Lock Nuts: Stainless steel.
5. Framing: Tube steel frame, as indicated in drawings.

B. Hardware:

1. Hinges: Weld-on barrel hinge with stainless steel pin. Rating: 1,000lbs per pair.
2. Latch: Recessed handle with drop latch bar. Basis of design: 0152.00023 Latch w/ custom spindle by Richards-Wilcox Inc.
3. Cane Bolts: 1" nominal diameter, galvanized. Basis of design: 0524.00021 Cane Bolt by Richards-Wilcox Inc.

C. Concrete:

1. Provide concrete consisting of portland cement complying with ASTM C150, aggregates meeting ASTM C33, and clean water.
2. Provide ready-mix concrete complying with ASTM C94, with minimum 28-day compressive strength of 2500 psi using at least four sacks of cement per yd^3, 1 inch maximum size aggregate, maximum 3 inch slump and 2 to 4 percent entrained air.

D. Wood Viewing railing:

1. Welded wire mesh size: 14 gauge, 2”x4” high rectangle.
2. Welded wire mesh finish: galvanized.G
3. Picket fasteners: Stainless steel carriage bolts, drill through pickets and rails.
4. Rails: 3” diameter round Peeled Eucalyptus.
5. Posts: 4” diameter round Peeled Cedar.
6. Pickets: 2”-2.5” diameter round Peeled Eucalyptus.
7. Rail fasteners: Carriage bolt sized appropriately to secure wood members, drill through rails and posts.
8. Mesh fasteners: Fencing staple gauge should be equal to or greater than the wire it is stapling.

E. Visitor mesh barrier:

1. Welded wire mesh size: 14 gauge, 2”x4” high rectangle.
2. Welded wire mesh finish: Galvanized.
3. Wood Posts: 4” diameter round Peeled Cedar.
4. Mesh fasteners: Fencing staple gauge should be equal to or greater than the wire it is stapling.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions and proceed with work in accordance with Section 017000.

3.2 INSTALLATION

A. Install in accordance with Division 1 and approved shop drawings.

B. Layout post locations and stake accurately. Arrange for Architect’s inspection and approval before setting posts.

C. Use templates and setting drawings to accurately place fasteners and intersecting pieces.

D. Terminate concrete 2 inches above finished grade and slope to of concrete for water runoff.

E. Set posts accurately, plumb and with tops in horizontal alignment dead level, or parallel to grade, as directed.

F. Brace posts in exact alignment and plumb.

G. Place concrete as detailed. Coordinate post mounting with curbs and other concrete assemblies as indicated in Drawings.

3.3 ASSEMBLING HARDWARE

A. Fasten hardware items securely, in careful alignment, for smooth, effortless operation and best appearance. Do not file or grind galvanized surfaces.

B. Use socket-headed screws, locknuts, “Nyloc” nuts and other appropriate fasteners to discourage disassembly by hand or with crude or common tools.

C. Make all fastenings tight and permanent, except at the removable fence connections.

3.4 HARDWARE SETS

	SET A		**Wood Gates**
2	Hinges	Weld-on Barrel, Galv	-
1	Latch Assembly	0152.00023 Latch	Richards-Wilcox
2	Cane Bolts	0524.00021 Cane Bolt	Richards-Wilcox

END OF SECTION

SECTION 329113
ANIMAL EXHIBIT SUBSTRATE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contract, including Exhibits and Attachments, the Drawings, and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes furnishing and spreading Sand Substrate for interior stalls, elephant day room, and for outdoor elephant yards.

1.3 SUBMITTALS

A. Product Data:
   1. For the following:
      a. Sand Analysis.
         (1) Furnish a sieve size analysis of sand classifying particle sizes, silt, soil, gravel, and organic content if any.
         (2) Particle sizes should be even and derived from mineral source such as silica.

B. Shop Drawings:
   1. NA

C. Samples
   1. 1 cubic foot sample of Sand Substrate mix of sand and topsoil.
   2. 1 cubic foot sample of proposed Gravel Substrate.
   3. Tag samples with name of project, source, quantity available, and date.

D. Manufacturers Qualifications
   1. Certifications specified in Quality Assurance article.

E. Warranty
   1. NA

1.4 QUALITY ASSURANCE

A. General: Comply with applicable Federal, State, County, and Local regulations governing landscape materials and work.

B. Employ only experienced personnel who are familiar with the required work. Provide adequate supervision by a qualified foreman.

C. Subcontract the soil preparation work to a single firm specializing in landscape work.

1.5 PRODUCT HANDLING

A. Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at the Project Site.

1.6 JOB CONDITIONS

A. Utilities:
   1. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required.

2. Prevent damage to temporary risers of underground sprinkling system and similar obstruction work located in landscape areas.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS.

A. Sand Substrate:

1. Even grained medium graded and washed sand with a grain size between 0.5 and 0.75 mm per ISO 14688-1.
2. Sand to be free of any foreign particles such as roots, stems, rocks, gravel, clay, or debris of any kind.
3. Sand shall be from 100% mineral particles and shall contain no organic material.

PART 3 - EXECUTION

3.1 SUBSTRATE MATERIAL PLACEMENT

A. General:
1. Proceed with and complete the soil preparation work as rapidly as portions of the Project Site become available, working within the seasonal limitations for each kind of landscape work required.
2. Cooperate with other contractors and trades working in and adjacent to landscape work areas.

B. Sand Substrate Placement:
1. Place first 12” course of sand over concrete floor. Compact mixture to 85% of dry density.
2. Place second 12” course of sand over first course of compacted sand. Compact mixture to 85% of dry density.
3. Place top course of sand to achieve a minimum depth of 12", compact to 80% of dry density. Add sand to create a flush condition with surrounding concrete floors.

3.2 GRADING

A. General: Rough grade to lines and contours per Drawings. Debris resulting from Contractor’s irrigation trenching and plant pit excavation shall be removed from site and not allowed to contaminate substrates.

B. Finish Grading: Fine grade plant beds to lines and grades shown. Fine finish topsoil by raking smooth and even and removing extraneous matter.

C. All holes, depressions, and rivulets shall be filled in and brought to a smooth grade. All sticks, branches, stones, or debris on the surface which will interfere with finish grading shall be picked up and removed from the site.

3.3 CLEAN-UP, PROTECTION, AND REPAIRS

A. During soil preparation work, store materials and equipment where directed. Keep pavements clean and work area in an orderly condition.

B. Protect soil preparation work from loss, damage, and deterioration during storage, installation, and maintenance period.

END OF SECTION

329200
TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding.

1.2 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Whatever soil is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Certification of grass seed.

1.5 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for turf growth.

a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

1.7 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion.

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Grass Seed Mix: State-certified seed of grass species as follows:
1. Exhibit Areas Seed Mix: Proportioned by weight as follows:

a. 35 percent Kentucky Bluegrass 98/55.
b. 20 percent VNS Hard Fescue.
c. 20 percent Creeping Red Fescue
d. 25 percent VNS Improved Fine Leaf Perennial Rye Grass

2. No Mow Lawn Seed Mix: Proportioned by weight as follows:

a. 40 percent Spartan II Hard Fescue.
b. 15 percent TXR Annual Ryegrass.
c. 40 percent Quatro Sheep Fescue.

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 4 lb./1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.3 PLANTING SOILS

A. Planting Soil Imported topsoil or manufactured topsoil from off-site sources; do not obtain from agricultural land, bogs or marshes. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following fertilizers in the following quantities to produce planting soil:
1. >.
2. Weight of Commercial Fertilizer per 1000 Sq. Ft. 5 lbs.

2.4 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley. Avoid non-biodegradable straw erosion mat materials and stakes.

2.5 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

A. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.

    a. Apply fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SEEDING

A. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 4 to 5 lb./1000 sq. ft. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

C. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.3 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain height appropriate for species without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings.

C. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.4 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10-sq. ft. and bare spots not exceeding 6 by 6 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

END OF SECTION

SECTION 329300
PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils
3. Mulches
4. Soil Amendments.

B. Related Sections
1. Section 310513 Soils for Earthworks

1.2 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

C. Finish Grade: Elevation of finished surface of planting soil.

D. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

F. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

G. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

H. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

I. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

J. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

K. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

B. Samples of mineral mulch.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.5 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for plant growth.

    a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

D. Preinstallation Conference: Conduct conference at **Project site**.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

B. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

C. Handle planting stock by root ball.

D. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg until planting.

E. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.7 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.

2. Warranty Periods from Date of Substantial Completion:

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period for Trees and Shrubs: Three months from date of Substantial Completion.
2. Maintenance Period for Ground Cover and Other Plants: Three months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

2.2 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

2.3 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1/2 lb./100 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

C. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 5-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.4 PLANTING SOILS

A. Planting Soil for raised shotcrete planters and bridge planter: Imported screened and blended topsoil or manufactured topsoil from off-site sources; do not obtain from agricultural land, bogs or marshes. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Topsoil by Volume: 1:4.
2. Weight of Commercial Fertilizer per 100 Sq. Ft.: ½ lb.
3. Weight of Slow-Release Fertilizer per 100 Sq. Ft.: Per manufacturer's instructions.

2.5 MULCHES

A. Organic Mulch: Finely Shredded hardwood bark

B. Leaf Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

2.6 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PLANTING AREA ESTABLISHMENT

A. Loosen grade of planting areas to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply three-inch cover of Compost and fertilizer directly to spread topsoil. Rototill compost and fertilizer into topsoil to depth of six inches.
2. Backfill Shotcrete Planters with imported screened blended topsoil Amend the installed topsoil with compost and fertilizer manually.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.2 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter.
2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.

B. Subsoil and topsoil removed from excavations **may** be used as planting soil.

3.3 TREE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set stock plumb and in center of planting pit or trench with root flare 2 inches adjacent finish grades.

1. Use planting soil for backfill.

2. Balled and Burlapped: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Container-Grown: Carefully remove root ball from container without damaging root ball or plant.
4. Fabric Bag-Grown Stock: Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
5. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting, pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
6. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
7. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.4 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

3.5 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.6 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Organic Mulch in Tree and Shrub Planting Areas: Apply 3-inch average thickness of mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
2. Organic Mulch in Perennial and Vine Planting Areas: Apply 2-inch average thickness of mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems

3.7 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use practices to minimize the use of pesticides and reduce hazards.

D. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

END OF SECTION 329300

SECTION 330507
POLYETHYLENE PRESSURE PIPE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Polyethylene (PE) and High-Density Polyethylene (HDPE) pipe for water.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 312319 – Site Dewatering.
   3. Section 312317 – Site Excavation, Backfill and Compaction.
   4. Section 331100 – Site Water System.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. ASTM D1248 – Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.
   2. ASTM D2239 - Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
   3. ASTM D2737 - Specification for Polyethylene (PE) Plastic Tubing.
   4. ASTM D3261 - Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
   5. ASTM D3350 - Specification for Polyethylene Plastics Pipe and Fittings Materials.
   6. ASTM F714 – Specification for Polyethylene (PE) Plastic Pipe (SDR DR) Based on Outside Diameter.
   7. ASTM F1473 – Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.

B. American Water Works Association (AWWA):
   1. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Product Data: Submit data indicating pipe, joints, fittings and pipe accessories.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify that product meets or exceeds specified requirements.

1.4 QUALITY ASSURANCE

A. Pipe, joints and fittings shall meet requirements of listed ASTM and AWWA Standards.

B. Products shall be marked and shall affirm that product was manufactured, inspected, sampled, and tested in accordance with ASTM and AWWA Specifications and has been found to meet requirements of specification.

1.5 REGULATORY REQUIREMENTS

A. Contractor shall comply with applicable rules and regulations of State of:
   1. Wisconsin Department of Natural Resources (WDNR), and other local, state, and federal agencies having jurisdiction related to Work of this Section.

B. Contractor shall comply with and be solely responsible for compliance with U.S. Department of Labor OSHA Part 1926 Safety and Health Regulations for Construction for this Work.

C. Contractor performing Work of this Section shall be solely responsible for identifying, furnishing, installing and maintaining equipment and materials required by state and federal regulations to establish safe working conditions during Work of this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Load and unload pipe, fittings, and accessories by lifting with hoists or skidding to avoid shock or damage.

B. Under no circumstances shall material be dropped.

C. Do not roll or side pipe handled on skidways against other pipe or ground.

D. Pad hooks or pipe tongs and use so as to prevent damage to exterior surface of pipe.

E. Keep stored pipe stored free of damage.

F. Keep interiors of pipe, fittings, and other appurtenances free from dirt or foreign matter.

G. Use timbers to separate pipe stored on ground from other pipe and ground.

H. Clearly mark pipe at intervals of not less than five feet with the following information:
   1. Manufacturer's name or trademark and production code.
   2. Nominal pipe outside diameter.
   3. PE cell classification.
   4. Type of pipe material and ASTM Designation for pipe.
   5. Dimensional ratio or pressure rating.

I. Clearly mark fittings with following information:
   1. Manufacturer's name or trademark.
   2. Nominal size.
   3. Material designation.
   4. ASTM D3261.

PART 2 PRODUCTS

2.1 POLYETHYLENE PRESSURE PIPE

A. Manufacturers;
   1. Charter Plastics, Inc., Titusville, PA.
   2. North American Pipe Corporation, Houston, TX.
   3. PLEXCO, Bensenville, IL.
   4. Substitutions: In accordance with Section 310200 – General Requirements for Sitework.

2.2 WATER MAIN

A. PE Pipe: AWWA C901 Polyethylene pipe and tubing; PE 334434C, Type III; nominal diameter 1/2-inch through 3-inch; SIDR-5.3, pressure class 200; butt fusion welded.

B. HDPE Pipe: ASTM F714 High density polyethylene; PE 3408 resin, cell classification 345464C; DR-17, 200 psi pressure rating; nominal diameter 4-inch through 36-inch as designated on Drawings; pipe OD sizes 3-inch to 54-inch shall be available in steel pipe sizes (IPS); butt fusion welded.

2.3 FITTINGS

A. Fittings shall be butt fusion fittings fabricated from polyethylene, Type III, Class C, Category 5 according to ASTM D1248, and shall conform to ASTM D3261.

B. Fittings shall be pressure rated to provide a working pressure rating no less than that of pipe:
   1. DR-15.5, 220 psi pressure rating.

C. Manufacture fabricated fittings using a McElroy Datalogger to record fusion pressure and temperature. A graphic representation of temperature and pressure data for fusion joints made producing fittings shall be maintained as part of quality control.

D. Fitting shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.

2.4 JOINTS

A. Butt Fusion: Sections of polyethylene pipe should be joined into continuous lengths on jobsite above ground. Joining method shall be butt fusion method and shall be performed in strict accordance with pipe manufacturer's recommendations.

1. Butt fusion equipment used in joining procedures should be capable of meeting all conditions recommended by pipe manufacturer, including, but not limited to, temperature requirements of 400 degrees F, alignment, and an interfacial fusion pressure of 75 psi.
2. Butt fusion joining will produce joint weld strength equal to or greater than tensile strength of pipe itself.

2.5 PIPE LOCATION MATERIALS

A. Identification Warning Tape: Underground warning tape, 2-inch width. Color-Bright Blue, warning message "Caution Buried WATER MAIN Below" to repeat every 30 inches.

B. Tracer Wire: 45 mil solid copper, No. 12 HMW-PE yellow jacket coating. Install to enable electronic locating of underground utility.

PART 3 EXECUTION

3.1 TRENCH METHOD

A. Pipe installation in trenches shall be in accordance with Section 312317 – Site Excavation, Backfill, and Compaction and Section 331100 – Site Water System.

3.2 FUSION JOINTS

A. Butt Fusion:

1. Individuals making heat fusion joints shall have received training in manufacturer's recommended procedure.
2. Heat fusion equipment shall meet manufacturer's requirements including 400 degree F temperature and 75 psi interfacial fusion pressure.
3. Equipment shall be capable of logging temperature, fusion pressure and graphic representation of fusion cycle.
4. Clamp pipes to be joined in place in above ground fusion machine. Each pipe shall be faced to assure smooth, flat joining surfaces.
5. Heat pipe ends for time and temperature recommended by pipe manufacturer for pipe diameter.
6. At end of heating time, carefully remove heater so as not to displace melt and bring pipe ends together within required timeframe.
7. Join ends with sufficient pressure to roll melt swell beads over to pipe surface.
8. Maintain pressure for time recommended by manufacturer for pipe diameter.
9. Allow an additional three minutes of cooling before removing from fusion machine and an additional 10 to 60 minutes, depending on pipe diameter, before rough handling or testing.

END OF SECTION

SECTION 331100
SITE WATER SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Site Piping.
   2. Pipe Fittings.
   3. Valves.
   4. Fire Hydrants.
   5. Domestic Water Services.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 310516 - Aggregates for Earthwork.
   3. Section 312317 – Site Excavation, Backfill, and Compaction.
   4. Section 330507 – Polyethylene Pressure Pipe.
   5. Section 331300 – Water Main Disinfection: Disinfection of site water piping.
   6. Section 331700 - Water Main Testing.

1.2 REFERENCES

A. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products.

B. American Society of Mechanical Engineers: (ASME)
   1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

C. ASTM International: (ASTM)
   1. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   2. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
   3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
   4. ASTM C33 - Standard Specification for Concrete Aggregates.
   5. ASTM C150 - Standard Specification for Portland Cement.
   6. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
   7. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

D. American Welding Society: (AWS)
   1. AWS A5.8 - Brazing Filler Metal.

E. American Water Works Association: (AWWA)
   1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   2. AWWA C105 - Polyethylene Encasement for Ductile Iron Pipe Systems.
   3. AWWA C110 - Ductile Iron and Grey Iron Fittings 3-In. Through 48-In., for Water.
   4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. AWWA C150 – Thickness Design of Ductile-Iron Pipe.
   6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
   7. AWWA C153 - Ductile-Iron Compact Fittings, 3-In. Through 24-In., for Water Service.
   8. AWWA C502 - Dry Barrel Fire Hydrants.
   9. AWWA C504 - Rubber Seated Butterfly Valves.
   10. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 In. through 24 In. NPS.
   11. AWWA C509 - Resilient Seated Gate Valves for Water Supply Service.
   12. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

13. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
14. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.

F. NSF International: (NSF)
1. NSF 14 - Plastics Piping System Components and Related Materials.
2. NSF 61 - Drinking Water System Components - Health Effects.

1.3 SITE WATER SUPPLY SYSTEM DESCRIPTION

A. Install site water supply system for areas indicated on Drawings and as follows:
1. Provide quick coupler connections, in boxes, with150 foot hose.

B. Shut-Off Valve: Provide shut-off valves to separate site water supply areas as detailed on Drawings.

C. Main System Drain: Provide main system drains as detailed on Drawings.

D. Lateral Drain: Provide in-line lateral drains as detailed on Drawings.

1.4 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

C. Manufacturer's Instructions: Indicate special procedures required to install Products specified.

D. Certificates: Certify that products meet or exceed specified requirements.

E. Loose equipment operating keys and spare parts will be furnished by Contractor in specified quantities:
1. Two quick coupler keys and matching swivel hose ells.
2. Two valve keys for gate valves.
3. Two sets of special tools required for removing, disassembling and adjusting each type of valve supplied on this project.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Division 01 – General Requirements: Submit operation and maintenance data.

C. Closeout Submittals:
1. Project Record Documents: Provide record of actual locations of concealed components, piping system and conduit.
2. Operation and Maintenance Data:
a. Submit instructions for operation and maintenance of system and controls, seasonal activation, and shutdown, and manufacturer's parts catalog.
b. Submit schedule indicating length of time each valve is required to be open to deliver determined amount of water.

1.6 REGULATORY REQUIREMENTS

A. Perform Work in accordance with requirements of:
1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

1.7 QUALITY ASSURANCE

A. Perform work in accordance with requirements of City of Milwaukee Water Utility for public connections and modifications where applicable.

B. Valves and Hydrants: Mark manufacturer's name and pressure rating on body.

C. Trenching, piping, wiring, product installation, and related operations shall be provided by a firm specializing in such work, who shall be responsible for its implementation and initial maintenance.

D. Work and materials shall be in accordance with latest rules and requirements of local ordinances or codes and other applicable laws or regulations.

E. Contractor shall obtain and pay for any permits for installation or construction of the Work included under this contract required by authorities having jurisdiction.

F. Contractor shall arrange for and pay costs in connection with any inspection and examination required by authorities having jurisdiction.

G. Make preliminary review of completed installation prior to backfilling of trenches and during hydrostatic testing.

H. Contractor is required to install, adjust, and maintain finished work at their expense for initial one year acceptance period.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 310200 – General Requirements for Sitework.

B. Deliver and store valves and gaskets in shipping containers with labeling in place.

PART 2 PRODUCTS

2.1 GENERAL

A. An acceptable certifying organization shall evaluate, test, and certify products intended for contact with potable water for conformance with NSF 61 and health effects portion of NSF 14.

B. Pipe, fittings, valves, hydrants, and valve boxes shall be manufactured in the United States of America.

C. Provide materials in accordance with:

1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

2.2 WATER PIPE

A. Ductile Iron Pipe: AWWA C151, Ductile Iron Pipe for water with AWWA C104 Cement Lining. Thickness Class 55 in accordance with AWWA C150.

1. Fittings: Ductile iron, AWWA C110 Standard.
2. Joints: AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings Mechanical Joint.
3. Corrosion Protection: AWWA C105 polyethylene encasement double layer, half lapped, 8 mil polyethylene.
4. Ductile Iron Pipe and Fitting Manufacturers:
   a. American Cast Iron Pipe Company.
   b. Griffin Pipe Products Company.
   c. McWane Cast Iron Pipe Company.
   d. Tyler Pipe Company.
   e. U.S. Pipe & Foundry Company Division of Mueller Water Products. Inc.
   f. Substitutions: In accordance with Section 310200 – General Requirements for Sitework.

B. Polyethylene pipe per Section 330507 – Polyethylene Pressure Pipe.

C. Copper Tubing:
   1. ASTM B88, Seamless Copper Water Tube, Type K, Form Coiled, annealed.
   2. Fittings: ASME B16.22, wrought copper pressure fitting.
   3. Joints: Compression connection or AWS A5.8, BCuP silver braze.

2.3 GATE VALVES

A. Manufacturers:
   1. American Flow Control.
   2. Kennedy Valve Company, Division of McWane, Inc.
   3. Mueller Company, Division of Mueller Water Products, Inc.
   4. U.S. Pipe and Foundry Company, Division of Mueller Water Products, Inc.
   5. Substitutions in accordance with Section 310200 – General Requirements for Sitework.

B. AWWA C509, Iron body, bronze trim, non-rising stem with square nut, single resilient wedge, mechanical joint ends, control rod, post indicator, extension box and valve key.

2.4 SWING CHECK VALVES - 2 INCH TO 24 INCH

A. Manufacturers:
   1. Kennedy Valve Company, Division of McWane. Inc.
   2. Mueller Company, Division of Mueller Water Products, Inc.
   3. Henry Pratt Company, Division of Mueller Water Products. Inc.
   4. Substitutions in accordance with Section 310200 – General Requirements for Sitework.

B. AWWA C508, iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.

2.5 CAST IRON VALVE BOXES

A. Manufacturers:
   1. Bingham & Taylor Corporation.
   2. Tyler Pipe Company.
   3. Substitutions in accordance with Section 310200 – General Requirements for Sitework.

B. Cast Iron Valve Box: 5-1/4 inch diameter shaft; round base; 5-1/4 inch drop lid marked "WATER"; length of assembly sized to span top of main to finished grade with a minimum adjustment remaining for an additional 3 inches.

2.6 VALVE BOX ADAPTERS

A. Gate Valve Adaptor: Epoxy-coated, 1/4-inch steel with 1/2-inch rubber gasket, size to fit valve. Similar and equal to adaptors manufactured by Adaptor, Inc., West Allis, WI.

2.7 HYDRANTS

A. Manufacturers:
   1. American Flow Control - Waterous Pacer WB-67-250.
   2. Clow, Division of McWane Corporation – Medallion.
   3. Kennedy Valve, Division of McWane. Inc. – Guardian K-81D.
   4. Mueller Company, Division of Mueller Water Products, Inc. – Super Centurion A423.
   5. Substitutions in accordance with Section 310200 – General Requirements for Sitework.

B. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length. Maximum of one (1) extension per hydrant may be used. If additional extension is necessary on hydrant with existing extension, remove existing extension and replace with single, adequate extension.

C. Hose and Streamer Connection: Match sizes with municipal utility, two hose nozzles, one pumper nozzle.

D. Finish: Primer and two coats of enamel in color required by Municipal Utility.

2.8 SERVICE FITTINGS

A. Manufacturers:
   1. Mueller Company.
   2. Ford Meter Box Company, Inc.
   3. A.Y. McDonald Mfg. Co.
   4. Substitutions in accordance with Section 310200 – General Requirements for Sitework.

B. Components:
   1. Saddles:
      a. Mueller Company, H-10500 Series.
      b. The Ford Meter Box Company, Style F202.
      c. A.Y. McDonald Mfg. Co, Model 3825.
      d. Substitutions in accordance with Section 310200 – General Requirements for Sitework.
   2. Corporation Stops:
      a. Mueller Company, H-15000 Series.
      b. The Ford Meter Box Company, FB-600.
      c. A.Y. McDonald Mfg. Co. 4701B.
      d. Substitutions in accordance with Section 310200 – General Requirements for Sitework.
   3. Curb Stops:
      a. Mueller Company, H-15154 Series.
      b. The Ford Meter Box Company, B22M Series.
      c. A.Y. McDonald Mfg. Co., 6104 Series.
      d. Substitutions in accordance with Section 310200 – General Requirements for Sitework.
   4. Curb Boxes (2 inch):
      a. Mueller Company, Series H-10304.
      b. The Ford Meter Box Company, Series EM2-XX-57.
      c. A. Y. McDonald Mfg., Co., Series 5615.
      d. Substitutions in accordance with Section 310200 – General Requirements for Sitework.

2.9 ACCESSORIES

A. Thrust Restraint:
   1. Concrete: ASTM C150 Portland cement and ASTM C33 aggregates, air-entrained concrete with minimum compressive strength of 3000 psi.
   2. Wedge-Action Joint Restraints: Cast iron, circular or a pair of semi-circles with wedges that grip PVC pipe. Product shall be Megalug as manufactured by EBAA Iron Sales, Eastland, TX, Uni-Flange as manufactured by Ford Meter Box Company, Inc., Wabash, IN., or an approved equal.
   3. Rod Restraints: ASTM A575 carbon steel, threaded rods with bitumastic coating and ASTM A563 nuts.
   4. Anchor Pipe: Ductile iron, thickness class 55, mechanical joint.

B. Backflow Preventer:
   1. FEBCO, CMB Industries, Inc., Fresno, CA.
   2. Watts Regulator Company, North Andover, MA.
   3. Zurn/Wilkins Water Control Products, Paso Robles, CA.
   4. Substitutions in accordance with Section 310200 – General Requirements for Sitework.

C. Pipe Location Materials.
   1. Identification Warning Tape: Underground warning tape, 2-inch width. Color-Bright Blue, warning message "Caution Buried WATER MAIN Below" to repeat every 30 inches.

2.10 TRACER WIRE MATERIALS

A. Mark non-conductive lateral pipes with a locating wire system.

B. Locating wire system consists of the following:
   1. Tracer Wire: 45-mil solid copper, No. 12 HMW-PE yellow jacket coating. Install to enable electronic locating of underground utility.

2. Tracer Wire Locating Box: 2-1/2-inch diameter, minimum, ABS pipe with 2 point terminal box and cast iron cover.
   a. Manufacturer: Valco, Inc. Model C.P. Mini Box, or an approved equal.

2.11 SITE WATER SUPPLY SYSTEM

A. Shut-Off Valves:
   1. Shut-off valves shall be bronze double-disc wedge type gate valves, with integral taper seats and non-rising stems, same size as line, as manufactured by:
      a. Milwaukee Valve Company (www.milwaukeevalve.com), (262) 432-2700.
      b. Substitutions: Owner's Representative shall approve proposed equivalent product prior to commencement of work.

B. Quick Couple Valves:
   1. Quick Couple Valves shall be brass, furnished with two valve keys, and fitted with 3/4-inch swivel hose, as manufactured by:
      a. Rain Bird Corporation (www.rainbird.com), (800) 724-6247.
      b. Substitutions: Owner's Representative shall approve proposed equivalent product prior to commencement of work.
   2. Locate quick couple valves at locations shown.

C. Valve Boxes:
   1. Valve boxes and covers shall be molded of green, temperature resistant thermoplastic materials suitable for enclosing main and lateral valves as detailed, as manufactured by:
      a. PENTAK Access Boxes (www.armoraccessboxes.com), (800) 348-7558.
      b. Substitutions: Owner's Representative shall approve proposed equivalent product prior to commencement of work.

D. Drain Valves:
   1. Manual Drain Valve per irrigation plan and detail shall be bronze double-disc wedge type gate valves, with integral taper seals and non-rising stems, same size as line, as manufactured by:
      a. Milwaukee Valve Company (www.milwaukeevalve.com), (262) 432-2700.
      b. Substitutions: Owner's Representative shall approve proposed equivalent product prior to commencement of work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that building service connection and water main size, location, and invert are as indicated.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with Type A2 aggregate as specified in Section 310516 – Aggregates for Earthwork.

B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

C. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 312317 – Site Excavation, Backfill, and Compaction for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Form and place concrete for pipe thrust restraints at any change of pipe direction as indicated on the Drawings. Place concrete to permit full access to pipe and pipe accessories.

C. Place bedding material in trench bottom, level fill materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent modified Proctor density.

D. Backfill around sides and top of pipe with bedding material to a depth of 24 inches above pipe, and compact to 95 percent modified Proctor density.

E. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Maintain separation of water main from sewer piping in accordance with:

1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

B. Install pipe to indicated elevation to within tolerance of 5/8-inch.

C. Install ductile iron piping and fittings in accordance with AWWA C600.

D. Route pipe as shown on the Drawings.

E. Install pipe to allow for expansion and contraction without stressing pipe or joints.

F. Install access fittings to permit disinfection of water system.

G. Slope water pipe and position drains at low points.

H. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

I. Establish elevations of buried piping as indicated on the Drawings.

J. Install tracer wire continuous over top of pipe. Secure tracer wire to top of pipe with industrial strength tape; coordinate with Section 312317 – Site Excavation, Backfill, and Compaction.

K. Backfill trench in accordance with Section 312317 – Site Excavation, Backfill, and Compaction. Do not displace or damage pipe when compacting.

3.5 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid concrete block bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.

D. Set hydrants to grade, with nozzles a minimum of 20 inches above finished grade.

E. Locate hydrant valve on hydrant lead a minimum of 24 inches from hydrant.

F. Provide a drainage pit 36 inches square by 24 inches deep filled with 6 inches of Type A11 clear stone, as specified in Section 310516 – Aggregates for Earthwork. Encase elbow of hydrant in clear stone to 6 inches above drain opening. Do not connect drain opening to sewer.

3.6 TRACER WIRE INSTALLATION

A. Lateral tracer wire originates and terminates in tracer wire access box located at right-of-way line. Install conductor tracer wire in one continuous loop.

B. Tape conductor tracer wire to top of pipe at minimum 10-foot intervals. Wrapping conductor tracer wire around pipe is prohibited.

C. Field test each locating wire after installation is completed.

3.7 DISINFECTION OF POTABLE WATER SYSTEM PIPING

A. Flush and disinfect system in accordance with City of Milwaukee requirements.

3.8 SERVICE CONNECTIONS

A. Provide water service to utility company requirements.

3.9 FIELD QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Field inspection and testing.

B. Request inspection prior to and immediately after placing bedding.

C. Perform moisture content testing and compaction testing in accordance with Section 312317 – Site Excavation, Backfill, and Compaction.

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

E. Frequency of Tests: As determined by Engineer and Testing Agency.

F. Pressure Test: Test in accordance with City and State requirements and

1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

3.10 PROTECTION OF FINISHED WORK

A. Section 310200 – General Requirements for Sitework: Protecting installed work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 332119
STORMWATER LIFT STATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Stormwater lift station.
   2. Initial operation of packaged pumping station.

1.2 RELATED REQUIREMENTS

A. Applicable provisions of Section 310200 - General Requirements for Sitework shall govern all work under this Section.

B. Section 310516 - Aggregates for Earthwork.

C. Section 312317 – Site Excavation, Backfill and Compaction.

D. Section 334100 – Site Storm Sewer System.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

1.4 SYSTEM DESCRIPTION

A. Pumping Station: Duplex; field assembled; with cast-in-place concrete wet well structure; centrifugal pumps; automatic control for above ground remote installation.

1.5 PERFORMANCE REQUIREMENTS

A. Wet Well Structure Wall: Sufficient to withstand water-saturated sand load of 120 pcf.

B. Wet Well Structure Cover: Support live load of 300 psf.

C. Pump Switch Operation:
   1. Locate four float level sensors consisting of "common stop", "start lead", "start lag", and "high level" in wet well. Start one pump automatically when "start lead" float is activated. Start second pump automatically when "start lag" float is activated. Signal alarm condition automatically when "high level" float is activated. Stop both pumps automatically when "common stop" float is activated. Set float elevations in accordance with Drawings. Set pumps to automatically switch operation from one pump to another after shut off of each pumping cycle.

1.6 SUBMITTALS

A. Section 310200 - General Requirements for Sitework: Requirements for submittals.

B. Product Data: Submit for each type of packaged pumping station.
   1. Include catalog data for wet well, cover, hinged door, slide rail assembly, discharge piping, valves, junction box, level controls, and control panel.
   2. Include pump catalog data, performance curve, breakaway fittings data, and access frame data.
   3. Include control panel data and panel wiring schematic.

1.7 CLOSEOUT SUBMITTALS

A. Section 310200 - General Requirements for Sitework: Requirements for submittals.

B. Record actual locations of packaged pumping station including wet well and control panel.

C. Submit executed certification of pumping station after performance testing.

D. Submit spare parts list and rebuild kits.

E. Provide Operations and Maintenance Manual containing operating and maintenance requirements for pumping station and schedule of recommended maintenance.

1.8 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum five (5) years documented experience and approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

A. Section 310200 - General Requirements for Sitework: Pre-installation meeting.

B. Convene minimum **one** week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 310200 - General Requirements for Sitework: Requirements for transporting, handling, storing, and protecting products.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of completed system.

D. Accept system components on site in manufacturer's original containers or configuration. Inspect for damage.

E. Store sensitive materials for field assembly in dry area in original shipping containers.

F. Support wet well structure with nylon slings to structural lift points during handling.

G. Repair damage to wet well structure according to manufacturer's instructions.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Section 310200 - General Requirements for Sitework: Environmental conditions affecting products on site.

B. Do not install wet well when bedding is wet or frozen. Dewater excavation to keep excavation dry.

PART 2 PRODUCTS

2.1 MATERIALS

A. Bedding, Ballast, and Backfill.

1. Bedding: Aggregate Type A1 as specified in Section 310516 – Aggregates for Earthwork.
2. Aggregate Backfill: Aggregate Type A2, as specified in Section 310516 – Aggregates for Earthwork.

2.2 WET WELL STRUCTURE SYSTEM

A. Concrete Wet Well Structure:

1. Precast or Cast in place reinforced concrete wet well structure.
2. Minimum wall thickness: As shown on the Drawings.
3. Size: As shown on the Drawings.

B. Concrete Cover: Reinforced concrete in accordance with Section 334100.

C. Access Hatch:

1. Extruded aluminum channel frame and cover, mill finish aluminum with bituminous coating applied to frame exterior, reinforced for 300 lbs/ft^2, heavy forged stainless steel hinges, compression spring operator with automatic hold-open army locks, Type 316 stainless steel slam lock with fixed interior handle and removable exterior turn/lift handle.
2. Fall protection grating system of aluminum with safety yellow powder coat paint finish, designed to meet OSHA 29 CFR 1910.23 requirements for fall protection, hold open device to lock cover in fully open 90 degree position, Type 316 stainless steel hardware.
3. Manufacturers:
   a. Bilco Type J-2AL.
   b. Substitutions: In accordance with Section 310200 – General Requirements for Sitework.

D. Rail System: Slide rail assemblies consisting of 304 stainless steel upper and lower rail brackets and pump guide brackets.

E. Junction Box: NEMA 250 Type 6 with cable grips for incoming direct burial cable.

F. Level Controls: Four mechanical float type or mercury type pilot duty liquid level controls with AWG 18-2 SJOW-A cable in polypropylene housing for mounting to PVC support pole.

2.3 PUMPS

A. Pump operation points:
1. 340 gpm at 29 feet TDH.
2. 400 gpm at 26 feet TDH.

B. Motor Horsepower (Max.): 5 horsepower.

C. Motor Speed (Max.): 1,750 rpm.

D. Power: 3 phase\60 hertz\460 volts.

E. Manufacturers:
1. Hydromatic S4SD.
2. Substitutions: In accordance with Section 310200 - General Requirements for Sitework.

2.4 CONTROL PANEL

A. Manufacturers:
1. Hydromatic.
2. Substitutions: In accordance with Section 310200 - General Requirements for Sitework.

B. Pump control panel shall include the following minimum components:
1. Free standing NEMA 3R stainless steel enclosure with inner door and skirting.
2. 100 amp main breaker.
3. Lightning arrestor.
4. Control transformer with two (2) control circuit breakers.
5. Pump breaker for each pump.
6. NEMA appropriate sized starter for each pump.
7. Elapsed Time Meter for each pump.
8. Manual resets through door.
9. LED style running light for each pump.
10. LED style motor overtemp light for each pump.
11. LED style pump seal fail light for each pump.
12. LED style High Water Alarm light.
13. Duplex pump controller with alternation.
14. HOA switch for each pump.
15. UL Panel construction.

C. Auxiliary Power Supply: Emergency standby electric generating system suitable to meet pump station power handling.

2.5 ACCESSORIES

A. Sealant: Industrial silicon sealant for pipe penetrations in wet well structure.

B. Anchor Bolts, Nuts, and Washers: ASTM A709/A709M, Grade 36, bent anchor bolts; ASTM A307, Grade A, nuts; ASTM A126, gray iron washers. Galvanize bolts, nuts and washers in accordance with ASTM A153/A153M.

2.6 SOURCE QUALITY CONTROL

A. Section 310200 - General Requirements for Sitework: Testing, inspection and analysis requirements.

B. Perform the following factory inspections and tests:
   1. Motor voltage and frequency check as shown on name plate.
   2. Motor and cable insulation test for moisture content or insulation defects in accordance with UL criteria.
   3. Submerged pump run test to determine pump meets hydraulic performance requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 310200 - General Requirements for Sitework: Verification of existing conditions before starting work.

B. Verify inlet and discharge piping connection are size, location, and elevation on Drawings.

3.2 WET WELL STRUCTURE INSTALLATION

A. Place, compact and level aggregate bedding to minimum 8 inches.

B. Form and place concrete base pad, trowel top surface level.

3.3 PUMP INSTALLATION

A. Install pump including fittings, brackets, discharge piping, check valve to wet well structure rail assembly, lifting device, and discharge. Wire pump to junction box.

3.4 CONTROL PANEL INSTALLATION

A. Mount and wire control panel for pumping station operation including triplex motor controls, circuit breaker, starter, control transformer, fuse box, terminal block, alternator, alarm and running lights, and auxiliary power supply generator.

B. Locate and connect direct burial cable from control panel to wet well structure junction box.

3.5 BACKFILL

A. Backfill wet well structure and direct burial cable in accordance with Section 312317 – Site Excavation, Backfill, and Compaction.

B. Maintain optimum moisture content of fill material to attain required compaction density.

C. Do not use wheeled or tracked vehicles for tamping.

3.6 STATION STARTUP, INITIAL TESTING AND OPERATION

A. Notify Architect/Engineer, seven (7) days prior to flow rate testing.

B. Provide startup and initial testing of system. Coordinate and operate pumps in conjunction with other construction of gravity interceptor.

C. Hydraulically test station to performance requirements by receiving, pumping and discharging 3,000 gallons of water to/from wet well structure.

D. Correct failures during test by repairing or replacing malfunctioning parts or equipment or faulty workmanship, regardless of cause, within 72 hours after notification from Architect/Engineer.

E. After correcting failures caused by defective equipment, material, or faulty workmanship, retest until failures are eliminated.

F. Confirm general sequencing of pump and float operations at wet well structure and control panel are in accordance with performance requirements.

G. Document and certify startup results in start-up report.

3.7 ADJUSTING

A. Section 310200 - General Requirements for Sitework: Requirements for starting and adjusting.

B. Adjust wet well structure, pump, and control panel systems so station operates to performance requirements and in accordance with specifications.

3.8 DEMONSTRATION

A. Demonstrate operation of pumping station - wet well structure components, pump system, and control panel.

END OF SECTION

SECTION 333100
SITE SANITARY SEWER SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Site Piping.
   2. Pipe Fittings.
   3. Precast Concrete Manholes with internal/external frame and chimney seals.
   4. Cleanouts.

B. Related Sections:
   1. Applicable provisions of Section 310200 - General Requirements for Sitework shall govern Work under this Section.
   2. Section 312317 - Site Excavation, Backfill, and Compaction: For sewerage system piping.

1.2 REFERENCES

A. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products.

B. American Association of State Highway and Transportation Officials: (AASHTO)
   1. AASHTO Standard Specifications for Highway Bridges.

C. American Concrete Institute: (ACI)
   1. ACI 318 - Building Code Requirements for Reinforced Concrete.

D. ASTM International: (ASTM)
   1. ASTM A240 – Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   2. ASTM A536 - Specification for Ductile Iron Castings.
   3. ASTM A615 - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   4. ASTM C33 - Specification for Concrete Aggregates.
   5. ASTM C150 - Specification for Portland Cement.
   6. ASTM C478 - Specification for Precast Reinforced Concrete Manhole Sections.
   7. ASTM C771 – Standard Test Method for Weight Loss After Heat Aging of Preformed Tape Sealants.
   8. ASTM C877 – Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
   9. ASTM C923 - Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
   10. ASTM C990 - Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   11. ASTM D2122 - Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
   12. ASTM D2321 – Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   13. ASTM D3034 - Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   14. ASTM D3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
   15. ASTM D4101 - Specification for Polypropylene Injection and Extrusion Materials.
   16. ASTM F477 - Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
   17. ASTM F593 – Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   18. ASTM F594 – Specification for Stainless Steel Nuts.

19. ASTM F679 - Specification for Poly(VinylChloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.
20. ASTM F1668 - Guide for Construction Procedures for Buried Plastic Pipe.

E. Code of Federal Regulations: (CFR)
   1. 29 CFR 1926.1053 - Ladders.

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Product Data: Provide data indicating pipe materials pipe fittings, and precast structures.

C. Submit Structural Design Calculations and detailed Shop Drawings for flattop and special precast concrete manhole structures prepared and sealed by a Professional Structural Engineer licensed in State of Wisconsin.

D. Design of flattop and special precast structures shall be in accordance with ACI 318 and ASTM C478.

E. Submit concrete mix data and test reports from an approved testing laboratory certifying that concrete used in precast structures conforms to specified requirements.

F. Manufacturer's Instructions: Indicate special procedures required to install Products specified.

G. Certificates: Certify that products meet or exceed specified requirements.

1.4 SUBMITTALS AT PROJECT CLOSEOUT

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Section 310200 – General Requirements for Sitework: Submit operation and maintenance data.

C. Section 310200 – General Requirements for Sitework: Submit Project Record Documents.
   1. Record actual locations of pipe runs, connections, structures, clean-outs, and invert elevations.
   2. Identify, indicate, and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 REGULATORY REQUIREMENTS

A. Contractor shall comply with applicable rules and regulations of
   1. State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for materials and installation of the Work of this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 310200 – General Requirements for Sitework.

B. Deliver and store castings and gaskets in shipping containers with labeling in place.

PART 2 PRODUCTS

2.1 GENERAL

A. Pipes, fittings, and structures shall be manufactured in the United States of America.

B. Materials supplied are to be in accordance with
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

2.2 PIPE MATERIALS

A. Polyvinyl Chloride (PVC) Pipe:
   1. Pipe: ASTM D3034, Type PSM, polyvinyl chloride (PVC) material; SDR 26, nominal inside diameter as shown on Drawings.
   2. Joint Device: Bell and spigot joint with ASTM F477 gasket. Joint shall conform to ASTM D3212.

2.3 PIPE FITTINGS AND ACCESSORIES

A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tees, bends, elbows, wyes, reducers, traps, and other required configurations.

2.4 TRACER WIRE MATERIALS

A. Mark all non-conductive lateral pipes with a locating wire system.

B. Locating wire system consists of the following:
   1. Tracer Wire: 45-mil solid copper, No. 12 HMW-PE yellow jacket coating. Install to enable electronic locating of underground utility.
   2. Tracer Wire Locating Box: 2-1/2-inch diameter, minimum, ABS pipe with 2 point terminal box and cast iron cover.
      a. Manufacturer: Valco, Inc. Model C.P. Mini Box, or an approved equal.

C. Identification Warning Tape: Heavy plastic underground warning tape, 2-inch width. Color-Bright Green, warning message "Caution Buried SANITARY SEWER Below" to repeat every 30 inches.

2.5 PRECAST REINFORCED CONCRETE MANHOLE SECTIONS

A. Precast Concrete Risers and Cone Sections: In accordance with ASTM C478, minimum wall thickness, one twelfth of internal diameter of riser or largest cone diameter plus 1 inch.

B. Precast Concrete Base Section with Integral Floor: In accordance with ASTM C478, minimum floor thickness 6 inches for risers up to 48-inches in diameter, and 8-inches for larger diameters; bench minimum slope 1/2-inch per foot from channel to wall; cast in place pipe sleeves.

C. Concrete Flat Slab Top: In accordance with ASTM C478 and approved Shop Drawings; Minimum thickness 6-inches for 48-inch diameter, 8-inches for larger diameters; equipped with lifting hooks.

D. Minimum access opening in cone or top section: 26-inch diameter.

E. Minimum compressive strength of concrete: 4000 psi.

F. Section shall support its own weight and live load equivalent to AASHTO HS-20 Highway Loading, unless otherwise indicated on Drawings.

G. Design exterior wall for a minimum equivalent fluid pressure of 90 pounds per square foot and consider additional lateral pressure from approaching truck wheels.

H. Form and cast openings with wall sleeves in base sections as required by Drawings.

I. Horizontal wall joints shall not be located within 18 inches of centerline of wall penetration.

J. Precast Section Joints: Reinforced concrete base and riser sections excepting grade rings, designed and formed with tongue and groove ends to produce a continuous, uniform manhole.

K. Identification Markings: Clearly mark on inside of each precast section date of manufacture and name or trademark of manufacturer. Clearly mark on outside of each section structure identification number from Drawings.

L. Precast concrete grade rings shall conform to ASTM C478.

2.6 MANHOLE STEPS

A. Rungs and Steps: Steel reinforced copolymer polypropylene plastic ASTM D4101 PP0344B33534Z02; ASTM A615, Grade 60 steel reinforced 1/2-inch diameter; size, placement and embedment shall conform to OSHA 29CFR 1926.1053 Ladders and ASTM C478; ends of legs tapered with fins for embedment.

1. Rungs and Steps in risers and conical sections: Aligned in each section to form continuous ladder with rungs equally spaced vertically in assembled manhole. Steps shall be 12 inches wide, 16 inches on center vertically, set into manhole wall.

2.7 MANHOLE FRAME AND COVER

A. Manufacturers:

1. Neenah Foundry Company, Neenah, WI.
2. East Jordan Iron Works Inc., East Jordan, MI.
3. U.S. Foundry & Manufacturing Corporation, Miami, FL.
4. Substitutions: In accordance with Section 310200 – General Requirements for Sitework.

B. Manhole Frame and Covers:

1. Ductile iron castings, ASTM A536, Grade 80-55-06, machined horizontal bearing surface, with concealed pickhole, gasketed, solid lid. Neenah Numbers used for identification.
   a. Neenah R-1661 manhole frame and lid.

2.8 PIPE AND JOINT SEALANTS AND GASKETS

A. Pipe Sleeve-Factory Cast in Place: ASTM C923, "Lock Joint Flexible Manhole Sleeve;" "KOR-N-SEAL;" or an approved equal, cast in precast base section.

B. Pipe Sleeve - Field Installed: ASTM C923, "KOR-N-SEAL" or an approved equal.

C. Tongue and Groove Preformed Joint Sealant: ASTM C990, preformed flexible joint sealant, Kent Seal No. 2 as manufactured by Hamilton-Kent; Ram-Nek as manufactured by K.T. Snyder Co.; or an approved equal.

2.9 INTERNAL/EXTERNAL FRAME/CHIMNEY SEAL

A. Flexible rubber sleeve shall be extruded or molded from high grade EPDM rubber compound conforming to applicable requirements of ASTM C877 and ASTM C923, with a minimum 1500 psi tensile strength, maximum 18 percent compressions set and durometer hardness of 48 plus/minus 5.

B. Stainless steel clamp and band shall be Type 304, 51 mm thick, 1/2-inch wide.

C. Butyl Tape: ASTM C771, temperature range of -70 degrees F. to 220 degrees F, tensile strength of 20 psi minimum.

D. Frame/chimney seal shall be Internal/External Adaptor Seal, by Adaptor, Inc. or an approved equal.

E. Length of wedge strip shall be such that, when its ends are butted together, it will cover entire inside circumference of that band recess needing slope adjustment.

F. Expansion bands used to compress sleeve against manhole shall be integrally formed from 16 gage, Type 304 stainless steel conforming to ASTM A240, with no welded attachments and shall have a minimum width of 1-3/4 inches.

G. Bands shall have a minimum adjustment range of 2 diameter inches and mechanism used to expand band shall have capacity to develop pressures necessary to make a watertight seal.

H. Band shall be permanently held in this expanded position with a positive locking mechanism. Any studs and nuts used for this mechanism shall be Type 304 stainless steel conforming to ASTM F593 and F594.

2.10 CLEANOUTS

A. Sanitary lateral shall have 6 x 4-inch wye for 4-inch ASTM D3034, SDR-35, cleanout pipe riser.

B. Riser pipe shall end in solvent welded Genova Products 30340 adaptor and Genova Products 31839 threaded plug, or approved equal.

C. Encase top of cleanout assembly in cast iron casting. Top of cleanout assembly shall be 2 inches below bottom of cover to prevent loads being transferred from frame and cover to piping.

D. Casting shall be Neenah Foundry R-1913, or an approved equal, cast into 12 x 12 x 6-inch thick concrete pad set flush with adjacent grade.

E. Cast-in-Place Concrete Pad: ASTM C150, Portland cement, and ASTM C33, 3/4-inch coarse aggregate and small and large grained sands, 6 per cent air-entrained concrete with minimum compressive strength of 3500 psi.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut and excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with Type A2, A3, or A9 aggregate as specified in Section 310516 – Aggregates for Earthwork.

B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

C. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 312317 – Site Excavation, Backfill, and Compaction for Work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place bedding material at trench bottom in accordance with Section 312317 – Site Excavation, Backfill, and Compaction.

C. Place and shape bedding material to pipe, to a minimum depth of three inches under bell and four inches under spigot and compact to 95 percent modified Proctor density.

D. Backfill around sides and top of pipe with bedding material to a loose lift depth of 15 inches above pipe and compact to 95 percent modified Proctor density.

E. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install PVC pipe in accordance with ASTM D2321 and ASTM F1668.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions.

C. Lay pipe to slope gradients noted on Drawings; with maximum variation from true slope of 1:1000.

D. Backfill trench in accordance with Section 312317 – Site Excavation, Backfill, and Compaction. Do not displace or damage pipe when compacting.

E. Coordinate the Work with termination of sanitary sewer connection outside building, connection to main, and trenching.

F. Install colored marker tape continuous over top of pipe, buried 18 inches below finish grade, above pipe line; coordinate with Section 312317 – Site Excavation, Backfill, and Compaction.

3.5 WATER AND SEWER SEPARATION

A. Sanitary sewer shall be installed at minimum required distances away from adjacent water mains and services as stipulated by:
   1. State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for materials for the Work of this Section.

3.6 TRACER WIRE INSTALLATION

A. Lateral tracer wire originates and terminates in tracer wire access box located at right-of-way line. Install conductor tracer wire in one continuous loop.

B. Tape conductor tracer wire to top of pipe at minimum 10-foot intervals. Wrapping conductor tracer wire around pipe is prohibited.

C. Field test each locating wire after installation is completed.

3.7 PREPARATION FOR STRUCTURES

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.8 INSTALLATION - MANHOLES

A. Excavation and Backfill:
   1. Excavate for manholes and drainage structures in accordance with Section 312317 – Site Excavation, Backfill, and Compaction in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
   2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes in dry trench.
   3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.
   4. Backfill excavations for manholes and drainage structures in accordance with Section 312317 – Site Excavation, Backfill, and Compaction.

B. Install manholes and drainage structures supported at proper grade and alignment on Type A2 or A3 aggregate, as specified in Section 310516 – Aggregates for Earthwork, bedding to a minimum compacted thickness as shown on Drawings.

C. Set base section, align pipe sleeve openings to provide straight alignment of pipe through manhole base, level and plumb sections.

D. Set manhole at a grade to assure that no more than 8 inches of precast concrete rings would be required to bring manhole frame and cover to final grade.

E. Lift precast structures at lifting points designated by manufacturer.

F. When lowering manholes and drainage structures into excavations and joining pipe to units, take precautions to ensure interior of structure remains clean.

G. Place preformed flexible joint sealant on either side of tongue portion of joint in base section to assure filling of entire joint when assembled.

H. Set riser section on base, aligning joint prior to setting, lower riser section level and uniformly on to base to squeeze joint compound throughout tongue and groove joint, visible for inspection both interior and exterior for water tight fit.

I. Trowel excess joint compound material flush at interior and exterior surface after placement.

J. Repeat process for remaining riser sections and top, exercising care to align ladder rungs to form uniform vertical ladder.

K. Section shall be vertical and in true alignment with a maximum 1/4-inch tolerance per section allowed.

L. Allow joints to set for a minimum 24-hour period before backfilling.

M. Plug holes in section required for handling or other purposes with non-shrink grout, finished flush on inside.

N. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

O. Cut pipe to finish flush with interior of structure.

P. Provide concrete flowline at bottom of lowest structure section to achieve sloped drainage from entering pipe to exiting pipe. Trowel smooth. Perform backfilling carefully, bringing fill up evenly on all sides.

Q. Compact fill around vault with a mechanical hand operated wacker.

3.9 INSTALLATION - PIPE SLEEVES

A. If an additional pipe sleeve is required in base section due to changed conditions, provide hole in section prior to it being set.

B. Core hole in base section of sufficient diameter to accommodate pipe and pipe sleeve, using care not to crack or splay concrete.

C. Install "KOR-N-SEAL" pipe sleeve in accordance with manufacturer's instructions.

D. Extend sanitary sewer pipe through pipe sleeves.

E. Extend minimum of two full lengths of pipe out from centerline of manhole in either direction.

F. Bring bedding material for pipe up to manhole face.

G. Provide a poured concrete bench sloped at 2 inches per foot to flow channel utilizing pipe for form.

3.10 INSTALLATION - MANHOLE FRAME AND COVER

A. Set frames using mortar and precast concrete adjustment rings as required.

B. Place precast concrete rings in full bed of mortar with completely fill joints. Verify maximum height of adjustment rings allowed by code prior to installing.

C. Plaster adjustment rings on both inside and outside of ring cylinder with mortar.

D. Place flexible joint sealant on centerline circumference of slab top or concrete ring with mortar bed placed on interior and exterior of sealant to full width of frame or ring area.

E. Where a bolted down frame is required, set bolts and tighten down nuts, leveling frame to finished grade.

3.11 FRAME/CHIMNEY SEAL INSTALLATION

A. Measure manhole to determine information necessary to order proper size sleeve and extensions.

B. Sealing surfaces shall be reasonably smooth, clean, and free of any form offsets or excessive honeycomb. Top internal portion of cone section shall have a minimum 3-inch high vertical surface.

C. Installation: Install per manufacturer’s instructions.

3.12 INSTALLATION OF CLEANOUTS

A. Install cleanouts in accordance with:
   1. State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for installation of the Work of this Section.

B. Form and place cast-in-place concrete pad with provision for frame and cover.

C. Establish elevations and inverts for cleanouts as indicated on Drawings.

D. Mount cleanout surface hub level in grout, to elevation indicated.

3.13 FIELD QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Field inspection and testing.

B. Request inspection prior to and immediately after placing bedding.

C. Perform compaction and moisture testing in accordance with Section 312317 – Site Excavation, Backfill, and Compaction.

D. Sewer System Testing:

1. Pressure Test: Test in accordance with State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.
2. Infiltration Test: Test in accordance with State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.
3. Deflection Test: Test in accordance with ASTM D2122.

3.14 PROTECTION OF FINISHED WORK

A. Section 310200 – General Requirements for Sitework: Protecting installed work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is completed.

END OF SECTION

SECTION 334100
SITE STORM SEWER SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sewer Pipe Materials.
   2. Pipe Fittings and Accessories.
   3. Catch Basins, including Frames and Grates.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 312317 – Site Excavation, Backfill, and Compaction: Excavating for storm sewer system piping.
   3. Section 334600 - Subdrainage: Termination of subdrainage tile system for connection to Work of this Section.

1.2 REFERENCES

A. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products.

B. American Association of State Highway and Transportation Officials: (AASHTO)
   1. AASHTO M294 – Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter.
   2. AASHTO Standard Specifications for Highway Bridges.

C. American Concrete Institute: (ACI)
   1. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

D. ASTM International: (ASTM)
   1. ASTM A48 – Specification for Gray Iron Castings.
   2. ASTM A536 - Specification for Ductile Iron Castings.
   3. ASTM A615 - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   4. ASTM C76 - Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   5. ASTM C270 - Specification for Mortar for Unit Masonry.
   6. ASTM C443 - Specification for Joints for Circular Pipe and Manholes, Using Rubber Gaskets.
   7. ASTM C478 – Specification for Precast Reinforced Concrete Manhole Sections.
   8. ASTM D2321 – Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
   9. ASTM D3034 - Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   10. ASTM D3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
   11. ASTM D3350 – Specification for Polyethylene Plastics Pipe and Fitting Materials.
   12. ASTM D4101 - Specifications for Propylene Plastic Injection and Extrusion Materials.
   13. ASTM F477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
   14. ASTM F1668 - Guide for Construction Procedures for Buried Plastic Pipe.
   15. ASTM F2306 - Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
   16. ASTM F2648 - Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

E. Code of Federal Regulations: (CFR)
   1. Title 29, Part 1926 Safety and Health Regulations for Construction, Occupational Safety and Health Administration (OSHA), U.S. Department of Labor.

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Product Data: Provide data indicating pipe materials, pipe fittings, and precast structures.

C. Submit Structural Design Calculations and detailed Shop Drawings for flattop and special precast concrete manhole structures prepared and sealed by a Professional Structural Engineer licensed in the State of Wisconsin.

D. Design of flattop and special precast structures shall be in accordance with ACI 318 and ASTM C478.

E. Submit concrete mix data and test reports from an approved testing laboratory certifying that concrete used in precast structures conforms to specified requirements.

F. Manufacturer's Instructions: Indicate special procedures required to install Products specified.

G. Certificate: Certify that Products meet or exceed specified requirements.

1.4 REGULATORY REQUIREMENTS

A. Contractor shall comply with applicable rules and regulations of
   1. State of Wisconsin Department of Natural Resources (WDNR) and local code if more stringent for materials and installation of the Work of this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 310200 – General Requirements for Sitework.

B. Deliver and store castings and gaskets in shipping containers with labeling in place.

PART 2 PRODUCTS

2.1 GENERAL

A. Pipes, fittings, and structures shall be manufactured in the United States of America.

B. Materials supplied are to be in accordance with:
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

2.2 PIPE MATERIALS

A. Reinforced Concrete Pipe:
   1. Pipe: ASTM C76, Class IV with Wall Type B; mesh reinforcement; inside nominal diameter as shown on Drawings.

B. Polyvinyl Chloride (PVC) Pipe:
   1. Pipe: ASTM D3034, Type PSM, polyvinyl chloride (PVC) material; inside nominal diameter as shown on Drawings.
   2. Joint Device: Bell and spigot style with ASTM F477 rubber ring sealed gasket. Joint shall conform to ASTM D3212.

C. Polyethylene Pipe:
   1. Pipe: ASTM F2648 (AASHTO M294), Type S, Polyethylene Pipe, ASTM D3350 polyethylene material, inside nominal diameter as shown on Drawings.
   2. Fittings: ASTM F2306.
   3. Joint Device: ASTM D3212 bell and spigot style, with ASTM F477 gasket joint.

2.3 PIPE FITTINGS AND ACCESSORIES

A. Fittings and fitting joints shall be in accordance with:
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

B. Fittings: Same material as pipe, molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

C. Mortar: ASTM C270, Type S.

D. Filter Fabric: Non-biodegradable, nonwoven:
   1. Carthage Mills, HS series
   2. TenCate North American Mirafi N series.
   3. Propex, Geotex Nonwoven series
   4. US Fabrics, Medium Weight NW series.

2.4 PIPE LOCATION MATERIALS

A. Identification Warning Tape: Heavy plastic underground warning tape, 2-inch width. Color-Bright Green, warning message "Caution Buried STORM SEWER Below" to repeat every 30 inches.

2.5 TRACER WIRE MATERIALS

A. Mark all non-conductive lateral pipes with a locating wire system.

B. Locating wire system consists of the following:
   1. Tracer Wire: 45-mil solid copper, No. 12 HMW-PE yellow jacket coating. Install to enable electronic locating of underground utility.
   2. Tracer Wire Locating Box: 2-1/2-inch diameter, minimum, ABS pipe with 2 point terminal box and cast iron cover.
      a. Manufacturer: Valco, Inc. Model C.P. Mini Box, or an approved equal.

2.6 PRECAST CONCRETE STRUCTURES INCLUDING FRAMES AND COVERS

A. Precast Concrete Risers and Cone Sections for Manholes, Catch Basins, and Inlets: In accordance with ASTM C478, minimum wall thickness, one twelfth of internal diameter of riser or largest cone diameter plus 1 inch.

B. Precast Concrete Base Section with Integral Floor: In accordance with ASTM C478, minimum floor thickness 6 inches for risers up to 48-inches in diameter, and 8 inches for larger diameters; bench minimum slope 1/2-inch per foot from channel to wall; cast in place pipe sleeves.

C. Concrete Flat Slab Top: In accordance with ASTM C478 and approved Shop Drawings; Minimum thickness 6 inches for 48-inch diameter, 8 inches for larger diameters; equipped with lifting hooks.

D. Minimum access opening in cone or top section: 24-inch diameter.

E. Minimum compressive strength of concrete: 4000 psi.

F. Section shall support own weight and live load equivalent to AASHTO HS-20 Highway Loading unless otherwise indicated on Drawings.

G. Design exterior wall for a minimum equivalent fluid pressure of 90 pounds per square foot and consider additional lateral pressure from approaching truck wheels.

H. Form and cast openings with wall sleeves in base sections as required by Drawings.

I. Horizontal wall joints shall not be located within 18 inches of centerline of wall penetration.

J. Section joints: Reinforced concrete base and riser sections excepting grade rings, designed and formed with tongue and groove ends to produce a continuous, uniform manhole.

K. Identification Markings: Clearly mark on inside of each precast section indicating date of manufacture, name or trademark of manufacturer. Clearly mark on outside of each section vault identification number from Drawings.

L. Precast concrete grade rings shall conform to ASTM C478.

M. Mortar: ASTM C270, Type S.

N. Reinforcement: Formed steel wire, galvanized finish.

O. Manhole Steps:

1. Steel reinforced copolymer polypropylene plastic ASTM D4101 PP0344B33534Z02; ASTM A615, Grade 60 steel reinforced 1/2 inch diameter formed; size, placement and embedment shall conform to OSHA 29 CFR 1926.1053 Ladders and ASTM C478; ends of legs tapered with fins for embedment.
2. Rungs and Steps in Risers and Conical Sections: Aligned in each section to form continuous ladder with rungs equally spaced vertically in assembled manhole. Steps shall be 12 inches wide, 16 inches on center vertically, set into manhole wall.

2.7 MANHOLE FRAME AND COVER

A. Manufacturers:

1. Neenah Foundry Company, Neenah, WI.
2. East Jordan Iron Works Inc., East Jordan, MI.
3. U.S. Foundry & Manufacturing Corporation, Miami, FL.
4. Substitutions: In accordance with Section 310200 – General Requirements for Sitework.

B. Manhole, Catch Basin, and Inlet Frame and Grate:

1. Manhole frame and grate: Ductile Iron Castings, ASTM A536, Grade 80-55-06, machined horizontal bearing surface: Neenah R 1760-A, or approved equal.
2. Inlets and catch basin frames and grates:
   a. Pavement: Ironsmith ADA 9032-DR with 9000FDR frame, grey iron, black/dip, 1/4-inch opening size; or approved equal.
   b. Lawn or Turf: Neenah R-2560-D, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that trench cut and excavation base are ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with Type A2 aggregate as specified in Section 310516 – Aggregates for Earthwork.

B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

C. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 312317 – Site Excavation, Backfill, and Compaction for Work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place and shape bedding material to pipe, to a minimum depth of three inches under bell and four inches under spigot and compact to 95 percent modified Proctor density.

C. Backfill around sides and top of pipe with bedding material to a loose lift depth of 15 inches above pipe and compact to 95 percent modified Proctor density.

D. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions and
   1. State of Wisconsin Administrative Code, Department of Safety and Professional Services, Chapter SPS 381 – Definitions and Standards, Chapter SPS 382 – Design, Construction, Installation, Supervision, and Inspection of Plumbing, and Chapter SPS 384 – Plumbing Products, and local code if more stringent for materials and installation of the Work of this Section.

B. Install PVC and polyethylene pipe in accordance with ASTM D2321 and ASTM F1668.

C. Install pipe, fittings, and accessories in accordance with manufacturer's instructions.

D. Lay pipe to slope gradients noted on Drawings; with maximum variation from true slope of 1:1000.

E. Backfill trench in accordance with Section 312317 - Site Excavation, Backfill, and Compaction. Do not displace or damage pipe when compacting.

F. Install colored marker tape continuous over top of pipe, buried 18 inches below finish grade, above pipe line; coordinate with Section 312317 – Site Excavation, Backfill, and Compaction.

3.5 PREPARATION FOR STRUCTURES

A. Coordinate placement of inlet and outlet pipe sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.6 INSTALLATION - STRUCTURES

A. Excavation and Backfill:
   1. Excavate for manholes and drainage structures in accordance with Section 312317 – Site Excavation, Backfill, and Compaction in locations and to depth shown. Provide clearance around sidewalls of structure for construction operations.
   2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes or drainage structures in dry trench.
   3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.
   4. Backfill excavations for manholes and drainage structures in accordance with Section 312317 - Site Excavation, Backfill, and Compaction.

B. Install manholes and drainage structures supported at proper grade and alignment on Type A2 or A3 aggregate bedding, as specified in Section 310516 – Aggregates for Earthwork, to a minimum compacted thickness as shown on Drawings.

C. Set base section, align pipe sleeve openings to provide straight alignment of pipe through manhole base, level and plumb sections.

D. Set manhole at a grade to assure that no more than 8 inches of precast concrete rings would be required to bring manhole frame and cover to final grade.

E. Lift precast structures at lifting points designated by manufacturer.

F. When lowering manholes and drainage structures into excavations and joining pipe to units, take precautions to ensure interior of structure remains clean.

G. Place preformed flexible joint sealant on either side of tongue portion of joint in base section to assure filling of entire joint when assembled.

H. Set riser section on base, aligning joint prior to setting, lower riser section level and uniformly on to base to squeeze joint compound throughout tongue and groove joint, visible for inspection both interior and exterior for water tight fit.

I. Trowel excess joint compound material flush at interior and exterior surface after placement.

J. Repeat process for remaining riser sections and top, exercising care to align manhole ladder rungs to form uniform vertical ladder.

K. Section shall be vertical and in true alignment with a maximum 1/4-inch tolerance per section allowed.

L. Allow joints to set for a minimum 24-hour period before backfilling.

M. Plug holes in section required for handling or other purposes with non-shrink grout, finished flush on inside.

N. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

O. Cut pipe to finish flush with interior of structure.

P. Provide concrete flowline at bottom of lowest structure section to achieve sloped drainage from entering pipe to exiting pipe. Trowel smooth. Perform backfilling carefully, bringing fill up evenly on all sides.

Q. Compact fill around vault with a mechanical hand operated wacker.

3.7 INSTALLATION - FRAME AND COVER

A. Set frames using mortar and precast concrete adjustment rings as required.

B. Place precast concrete rings in full bed of mortar with completely fill joints. Verify maximum height of adjustment rings allowed by code prior to installing.

C. Plaster adjustment rings on both inside and outside of ring cylinder with mortar.

D. Place flexible joint sealant on centerline circumference of slab top or concrete ring with mortar bed placed on interior and exterior of sealant to full width of frame or ring area.

E. In non-pavement areas set frame and cover two inches above finished grade for manholes and other structures with covers to allow area to be graded away from cover beginning 1-inch below top surface of frame.

3.8 TRACER WIRE INSTALLATION

A. Originate and terminate lateral tracer wire in wire access box located at right-of-way line. Install conductor tracer wire in one continuous loop.

B. Tape conductor tracer wire to top of pipe at minimum 10-foot intervals. Wrapping conductor tracer wire around pipe is prohibited.

C. Field test each locating wire after completing installation.

3.9 FIELD QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Field inspection and testing.

B. Perform compaction and moisture content testing in accordance with Section 312317 - Site Excavation, Backfill, and Compaction.

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: As determined by Engineer and Testing Agency.

E. Deflection Test: Deflection tests shall be performed for all polyvinyl chloride (PVC) and polyethylene pipe installations.

1. Deflection test shall be performed using a rigid ball or mandrel without a mechanical pulling device.

2. If deflection testing occurs within 30 days of placement of final backfill, deflection shall not exceed 5 percent.
3. When deflection testing occurs more than 30 days after placement of final backfill, maximum deflection shall not exceed 7.5 percent.

3.10 PROTECTION OF FINISHED WORK

A. Section 310200 – General Requirements for Sitework: Protecting installed work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is completed.

END OF SECTION

SECTION 334600
SUBDRAINAGE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe Materials.
   2. Aggregate and Bedding.
   3. Accessories.
   4. Underdrain Installation.

B. Related Sections:
   1. Applicable provisions of Section 310200 – General Requirements for Sitework shall govern Work under this Section.
   2. Section 310513 – Soils for Earthwork.
   3. Section 310516 - Aggregates for Earthwork.
   4. Section 312317 – Site Excavation, Backfill, and Compaction: Excavating and backfilling for drainage system piping and surrounding filter aggregate.
   5. Section 321123 - Aggregate Base Course.
   6. Section 334100 - Site Storm Sewer System.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials: (AASHTO)
   1. AASHTO M 252 - Corrugated Polyethylene Drainage Pipe.

B. ASTM International (ASTM):
   1. ASTM C923 - Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
   2. ASTM D2321 – Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
   3. ASTM D2729 - Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   4. ASTM D3887 – Specification for Tolerances for Knitted Fabrics.
   5. ASTM D5034 - Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).
   6. ASTM F405 - Specification for Corrugated Polyethylene (PE) Pipe and Fittings.
   7. ASTM F667 - Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings.

C. United States Department of the Army, Corps of Engineers, Office of the Chief of Engineers:
   1. CW-02215 - Civil Works Construction Guide Specification for Plastic Filter Fabric.

D. Wisconsin Department of Transportation:
   1. Standard Specifications for Highway and Structure Construction, Current Edition. (WISDOT)

1.3 SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Shop Drawings: Indicate dimensions, layout of piping, high and low points of pipe inverts, and gradient of slope between corners and intersections.

C. Product Data: Submit data on pipe drainage products and pipe accessories.

D. Manufacturer’s Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 310200 – General Requirements for Sitework: Requirements for submittals.

B. Section 310200 – General Requirements for Sitework: Closeout procedures.

C. Section 310200 – General Requirements for Sitework: Submit Record Drawings showing location of pipe runs, connections, cleanouts, and principal invert elevations.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

A. Polyvinyl Chloride Pipe: ASTM D2729; plain end, size as indicated on the Drawings; with required fittings.

B. Corrugated Polyethylene Pipe: AASHTO M 252, Type CP, ASTM F405, and ASTM F667, flexible type; 4-inch and 6-inch diameter, with required fittings.

C. Use perforated pipe for subdrainage system; unperforated through sleeved walls.

2.2 AGGREGATE AND BEDDING

A. Filter Aggregate and Bedding Materials: Fill Type A11 as specified in Section 310516 - Aggregates for Earthwork.

2.3 ACCESSORIES

A. Joints: Gasketed, Water-tight.

B. Geotextile Fabric:

1. Non-biodegradable, nonwoven fabric made from 100 percent polypropylene staple filaments.
2. Manufacturers: Carthage Mills FX-30HS, TenCate Geosynthetics North America Mirafi 140NL, Propex Inc. Geotex 311, or US Fabrics, Inc. 80NW.

C. Pipe Sleeve - Factory Cast-in-Place: ASTM C923, "Lock Joint Flexible Manhole Sleeve," "KOR-N-SEAL," or an approved equal, cast in precast base section.

D. Pipe Sleeve - Field Installed: ASTM C923, "KOR-N-SEAL" or an approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 310200 – General Requirements for Sitework: Coordination and project conditions.

B. Verify trench cut and excavated base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with Type A2 or A3 aggregate as specified in Section 310516 – Aggregates for Earthwork.

B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction.

3.3 UNDERDRAIN INSTALLATION

A. Excavate trench as indicated on the Drawings in accordance with Section 312317 - Site Excavation, Backfill, and Compaction.

B. Line trench with geotextile providing excess to close top of drainage cell.

C. Place perforated pipe at centerline of trench on top of geotextile. Lay pipe at slope shown in Drawings.

D. Fill trench to as indicated on the Drawings in accordance with Section 310516 – Aggregates for Earthwork.

E. Close geotextile over open graded aggregate with a 12-inch lap.

3.4 FIELD QUALITY CONTROL

A. Section 310200 – General Requirements for Sitework: Testing and inspection services.

B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 310200 – General Requirements for Sitework: Protecting installed construction.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is completed.

END OF SECTION

SECTION 412213
OVERHEAD UNDER-RUNNING BRIDGE CRANES WITH ELECTRIC POWERED HOISTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Provision of specially fabricated, welded steel rails for construction of overhead single girder bridge crane. Section also includes trolleys and end trucks compatible with crane rails.
   2. Overhead Under-Running Bridge Cranes system with electric powered hoist.
   3. Overhead Under-Running Bridge Cranes system with electric trolley operation.
   4. Radio Controlled operation.

B. Related Sections:
   1. Applicable provisions of Division 01 shall govern all work under this Section.
   2. Section 051200 – Structural Steel Framing.
   3. Division 26 – Electrical: Electrical supply, conduit, wiring, and electrical components for powering crane system.

1.2 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. AISC 325 – Steel Construction Manual.
   2. AISC 348 – Structural Joints Using ASTM A325 or A490 Bolts.
   3. AISC 360 – Specification for Structural Steel Buildings.

B. American National Standards Institute (ANSI):
   1. ANSI B30.11 – Monorails and Underhung Cranes.
   2. ANSI MH27.1 – Specifications for Underhung Cranes and Monorail Systems.

C. ASME International (ASME):
   1. ASME B30.10 – Hooks.
   2. ASME B30.11 – Monorails and Underhung Cranes
   3. ASME B30.16 – Overhead Hoists (Underhung)
   4. ASME HST-1 – Electric Chain Hoists.
   5. ASME HST-4 – Overhead Electric Wire Rope Hoists.

D. ASTM International (ASTM):
   1. ASTM A36 - Standard Specification for Carbon Structural Steel.
   2. ASTM A275 – Magnetic Particle Examination of Steel Forgings.
   3. ATM A325 – Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   4. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
   5. ASTM A563 – Carbon and Alloy Steel Nuts.
   6. ASTM F959 – Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.

E. American Welding Society (AWS):
   1. AWD D14.1 – Welding of Industrial and Mill Cranes and Other Material Handling Equipment.

F. Monorail Manufacturers Association (MMA):
   1. MMA MH 27.1 – Underhung Cranes and Monorail Systems.

G. National Electrical Manufacturers Association (NEMA):
   1. NEMA ICS 6 – Enclosures.
   2. NEMA ICS 8 – Crane and Hoist Controllers.
   3. NEMA MG 1 – Motors and Generators.

H. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code.

I. Occupational Safety and Health Administration (OSHA):
   1. OSHA Specification 1910.179 – Overhead and Gantry Cranes.

J. U.S. General Services Administration (GSA):
   1. FS RR-W-410 – Wire Rope and Strand.

K. U.S. National Archives and Records Administration (NARA):
   1. 29 CFR 1910.179 – Overhead and Gantry Cranes.

1.3 SYSTEM DESCRIPTION

A. Provide an overhead under-running bridge crane system with electric powered hoist and electric powered trolley complete, tested and ready for operation.

B. Track for overhead bridge crane runway shall be overhead suspended in layout indicated and dimensioned on the Drawings. Crane operating area shall be free of crane support structures. Crane track shall be custom designed and engineered, factory fabricated, and site assembled and erected.

C. Bridge crane, hoist, trolleys, equipment, materials, installation, examination, inspection, and workmanship shall be in accordance with the applicable requirements of NFPA 70, ASME B30.10, ASME B30.11, ASME B30.16, ASME HST-1, ASME HST-4, and MMA MH27.1, with modifications specified herein. Reference in these publications to the "authority having jurisdiction" shall be interpreted to mean the "Contracting Officer."

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01 – Submittal Procedures:

B. Shop Drawings – Bridge Crane System.
   1. Shop drawings showing bridge crane runway, bridge girder configurations, dimensions, and fabrication and installation details.

C. Product Data:
   1. Bridge crane track system including switches, suspension system and other components. Describe capacities, performance, operation, and applied forced to [overhead] [floor] support framing.
   2. Electric wire rope hoist.
   3. Trolley.
   4. Radio controlled pushbutton station.
   5. Electrification.

D. Design Data:
   1. Load and sizing calculations.
   2. Manufacturer’s standard pre-engineered load tables and other data annotated to identify Project selections and conditions.
   3. Indicate type, size, material, spacing, and other attributes of components being provided to accommodate performance requirements specified.

E. Manufacturer’s installation instructions.

F. Test Report
   1. Wire rope breaking strength test.
   2. Hook and hook nut magnetic particle inspection.
   3. Post-erection inspection.
   4. Operational tests.
   5. Hook test.
   6. No-load test.
   7. Load test.
   8. Rated load speed test.

G. Certificates:
   1. Bolts
   2. Nuts
   3. Washers
   4. Painting system
   5. Overload test certificate

H. Copy of warranty required for review by Engineer/Architect.

I. Operation and Maintenance Data:
   1. Overhead bridge crane system, Data Package 3.
   2. Submit in accordance with Division 01 – Operation and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings.

B. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, including subfreezing temperatures, precipitation, and high winds.

C. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures.

D. Do not store materials directly on ground.

E. When special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or it's crating.

F. Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to Owner.

1.6 QUALITY ASSURANCE

A. Manufacturer: Company specializing in designing and manufacturing cranes with 25 years successful experience.

B. Bridge crane runway and bridge girder shall be designed, fabricated, and installed in accordance with ANSI B30.11 and OSHA 1910.179.

C. Perform welding by certified operators in accordance with AWS D14.1.

D. Bolted connections shall be in accordance with torque tightening procedures specified in AISC Manual, Part 5.

E. .Certificates: Overload Test Certificate
   1. Submit a statement that the bridge crane system can be periodically load tested to 125 percent (plus 5 minus 0) of rated load.

F. Drawings: Bridge Crane System:
   1. Show the general arrangement of all components, clearances and principal dimensions, assemblies of hoist, trolley, track, track suspension system, and electrical schematic drawings.

G. Design Data: Load and Sizing Calculations:
   1. Submit calculations verifying the sizing of any track, track suspension device and additional supports which are not the bridge crane system manufacturer's standard cataloged product.

1.7 WARRANTY

A. Provide under provisions of Division 01 – Closeout Submittals.
   1. Five (5) year warranty for crane track to cover defects in materials and workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Harrington.

B. R&M Material Handling.

C. Whiting.

D. Demag.

E. Konecranes.

F. Cleveland Tramrail® by Gorbel, Inc.

G. Substitutions: In accordance with Division 01 – General Requirements.

2.2 BRIDGE CRANE RUNWAY

A. Type: Three-piece, full penetration continuous weld assembly, Tarca Track as manufactured by Cleveland Tramrail® by Gorbel, Inc. Standard structural steel rolled I-beam sections with beveled flanges are not acceptable as bridge crane runway.

B. Maximum track deflection: Smaller of 1/450 span or 1-1/4 inches.

C. Factory finish track ends without rough cuts. Factory drill or punch holes required for installation.

D. Factory preparation: Factory prepare track with slotted holes for suspending and anchoring track and connecting track sections. Track shall be delivered to site completely prepared for installation.

2.3 BRIDGE CRANE RUNWAY SUSPENSION SYSTEM

A. Design and provide runway suspension system for bridge crane including suspension assemblies, fittings, anchors, auxiliary framing, bracing, and other components for complete, functional installation and to meet requirements.

2.4 OVERHEAD BRIDGE CRANE SYSTEM

A. Provide overhead bridge crane system conforming to MMA MH27.1, Class C, for indoor service, with an electric wire rope or chain hoist mounted on a movable trolley.

B. Trolley shall be motor operated. Bridge crane system shall operate on 460 or 230 volts AC, 60 Hz, three phase power source.

C. Bridge crane system shall have a minimum rated capacity of five (5) tons. Mark the hoist capacity in tons on both sides of the hoist or load block.

D. The hoist shall have variable operating speeds and shall be capable of hoisting and lowering the rated load at a speed of 2 to 20 feet per minute (fpm).

E. The trolley shall have variable operating speeds and shall be capable of moving the rated load at a speed of 2 to 50 fpm.

F. The bridge shall have variable operating speed and shall be capable of moving the rated load at a speed of 2 to 50 fpm.

G. Material Limitations: Shafts, keys, couplings, sprockets, and chains shall be steel. All gears shall be steel except for worm gears, which shall be bronze or steel. Cast iron and aluminum used to support components of the hoist power transmission train shall be ductile.

H. Safety: Comply with the mandatory and advisory safety requirements of ASME B30.10, ASME B30.11, ASME B30.16, and 29 CFR 1910.179.

2.5 TROLLEY BEAM SYSTEM

A. MMA MH27.1. Trolley beams shall be patented track sections fabricated by a manufacturer regularly engaged in production of this type of beam or hot rolled wide flange or hot rolled S shapes.

B. Support trolley beam from the structural runway beam members shown.

2.6 ELECTRIC WIRE ROPE HOIST

A. ASME HST-4, Class H3, except as modified herein. Hoist shall be double reeved.

B. Hoisting Ropes: FS RR-W-410, improved or extra improved plow steel, regular lay, uncoated, 6 by 37 class construction, with an independent wire rope core. Provide proof of wire rope breaking strength test report.

C. Sheaves shall be steel or ductile cast iron. Pitch diameter of running sheaves shall not be less than 16 times the rope diameter. Pitch diameter of non running sheaves shall not be less than 12 times the rope diameter.

D. Drum shall be steel or ductile cast iron. Pitch diameter of the drum shall not be less than 18 times the rope diameter. Not less than two dead wraps of the hoisting rope shall remain on each anchorage when the hook is in its extreme low position.

2.7 TROLLEY

A. Trolley shall meet all applicable requirements of MMA MH27.1, ASME HST-1 and ASME HST-4.

B. Trolley shall have elastomeric bumpers to engage runway stops.

2.8 MOTORS

A. NEMA MG 1. Hoist and trolley motors shall be variable speed AC squirrel cage induction type. Trolley motor shall be variable speed AC squirrel cage induction type.

B. Motor insulation shall be Class B minimum.

C. Provide totally enclosed non-ventilated (TENV) motor enclosures.

D. Maximum motor speed shall not exceed 1800 RPM.

2.9 CONTROLS

A. Provide magnetic control for the hoist and trolley.

B. Provide reduced voltage starting, acceleration and deceleration for the trolley drive.

2.10 LIMITS SWITCHES

A. Provide upper and lower limit switches which de-energize the hoist motor.

2.11 BRAKES

A. Provide hoist with an electro-mechanical holding brake and a mechanical load brake, each capable of holding 130 percent of the rated hoist capacity. Hoist holding brake shall be capable of being released to test the load brake.

B. Provide trolley with an electro-mechanical brake. Provide trolley brake with a minimum torque rating of 100 percent of the drive motor rated torque. Trolley brake torque shall be adjustable down to 85 percent of its torque rating.

2.12 LOAD BLOCK AND HOOK

A. Construct load blocks of steel.

B. Provide forged steel, swivel type hook, with hook nut keyed to hook shank by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or other similar easily removable securing device.

C. Provide hook with spring loaded steel safety latch for closing the hook throat opening. The hook and hook nut shall be unpainted.

D. Permanently mark hook and hook nut with an identification number.

E. Hook and Hook Nut Magnetic Particle Inspection:

1. Magnetic particle inspect the hook and nut over the entire area in accordance with ASTM A275/A 275M.
2. Acceptance standard shall be no defects. A defect is defined as a linear indication that is greater than 3 mm 1/8 inch long whose length is equal to or greater than three times its width.

2.13 BEARINGS

A. All bearings except those subject to a small rocker motion shall be anti-friction type.

B. Bearings not considered lifetime lubricated by the manufacturer shall be provided with a means for lubrication.

2.14 RADIO CONTROL STATION

A. The remote radio control system must be designed to meet the requirements of NEMA ICS 8, Part 9. Provide radio control system conforming to FCC Part 15 (unlicensed frequencies).

B. The remote radio control shall use rechargeable Ni-Cad batteries. A spare battery with battery charger shall be provided. Provide the cost difference to supply the radio control with alkaline batteries.

C. The radio control shall be a pendant type and have the following buttons: power on and off switch, power on/battery monitor light; three step reversing bridge.

2.15 ELECTRIFICATION

A. Runway electrification shall be of the enclosed safety bar type with four continuous copper conductors.

B. Provide electrical work for the bridge crane system in accordance with NFPA 70 and Section 16402 - Interior Distribution System.

2.16 IDENTIFICATION PLATES

A. Provide identification plates of noncorrosive metal with clearly legible permanent lettering giving the manufacturer's name, model number, capacity in pounds, and other essential information or identification.

2.17 PAINTING SYSTEM

A. Painting shall be manufacturers standard. Provide a primer and a finish coat.

B. Blast clean all components prior to painting.

C. Primer shall be inorganic zinc type.

D. The finish coat shall be an epoxy coating.

E. Paint coats shall be smooth and even, free of runs, sags, orange peel, or other defects.

PART 3 EXECUTION

3.1 ERECTION AND INSTALLATION

A. Erect and install the bridge crane system, complete in accordance with the approved submittals and in condition to perform the operational and acceptance tests.

B. Install crane rails and accessories in accordance with manufacturer’s instructions and reviewed shop drawings. Do not modify crane rails in any manner without advance, written approval from rail manufacturer.

3.2 ERECTION SERVICES

A. Provide supervisory erection services from the bridge crane system manufacturer.

3.3 FIELD QUALITY CONTROL

A. Post-Erection Inspection:
   1. After erection, the Contractor and the Contracting Officer shall jointly inspect the bridge crane and hoist systems and components to determine compliance with specifications and approved submittals.
   2. The Contractor shall notify the Contracting Officer five (5) days before the inspection.
   3. Provide a report of the inspection indicating the bridge crane system is considered ready for operational tests.

B. Operational Tests:
   1. After erection and inspection, test the hoist, and trolley as specified herein.
   2. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacturer, installation, and workmanship.
   3. Rectify all deficiencies disclosed by testing and retest the system or component to prove the monorail system is operational.
   4. The Contractor shall furnish loads for testing, operating personnel, instruments, and all other necessary apparatus.

C. Test Data:
   1. Record test data on appropriate test record forms suitable for retention for the life of the monorail system.
   2. Record operating and startup current measurements for electrical equipment (motors and coils) using appropriate instrumentation (i.e., clamp-on ammeters).
   3. Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed.
   4. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected.
   5. Record hoist and trolley speeds during each test cycle.

D. Hook Test:
   1. Measure hook for hook throat spread before and after load test.
   2. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 0.4 mm 1/64 inch). Record this base dimension.
   3. Measure the distance between tram points before and after load test. An increase in the throat opening by more than 5 percent from the base measurement shall be cause for rejection.

E. No Load Test:
   1. Hoist: Raise the load hook the full operating lift distance and verify satisfactory operation of hoist, upper limit switch, lower limit switch, and the hoisting and lowering speeds. Operate the hoist in both directions.
   2. Trolley: Operate trolley assembly the full length of the monorail in both directions. Operate trolley in each direction. Verify satisfactory operation and verify trolley speed.

F. Load Test: 125 Percent (plus 5 percent minus 0) of rated capacity
   1. Hoist Static Test: Raise test load approximately one foot above the floor and hold for 10 minutes. Observe load lowering that may occur which will indicate malfunction of hoisting component or brake. Lower the test load to the floor until the hoist line is slack.
   2. Hoist Dynamic Test: Raise the test load to approximately 1.5 m 5 feet above the floor using all speed points in the process. Lower the load back to the floor using all speed points. Stop the test load at least once while lowering at high speed and observe proper brake operation. Wait 5 minutes, then repeat the above cycle.
   3. Load Brake Test: Raise test load approximately 1.5 m 5 feet. With the hoist controller in the neutral position, release the holding brake. The load brake should hold the test load. Again with the holding brake in the released position, start the test load down at low speed and return the controller to off position as the test load lowers. The load brake should prevent the test load from accelerating. NOTE: It is not necessary for the load brake to halt the downward motion of the test load.

4. Loss of Power Test: Raise the test load approximately 1 m 3 feet and while lowering test load at low speed, cut main power to hoist. Load should stop.
5. Trolley Test: With test load hoisted to a height of one foot above the floor, operate trolley the full distance of the trolley in both directions using all speed points in the process. Observe for any malfunctioning of the trolley assembly and trolley system.
6. Bridge Test: With test load hoisted to a height of one foot above the floor, operate bridge the full distance of the runway beams in both directions using all speed points in the process. Observe for any malfunctioning of the trolley assembly and runway bridge beam system.

G. Rated Load Speed Test:
1. With the hoist loaded to rated capacity, raise and lower the load verifying that the hoisting and lowering speeds are provided as specified.
2. With the hoist loaded to rated capacity, operate trolley along the trolley beam verifying that the trolley speed is provided as specified. Further, verify that the trolley stops in each direction within a distance (in feet) equal to 10 percent of rated capacity high speed (in feet per minute) when initially traveling at high speed and carrying the rated capacity load.
3. With the hoist loaded to rated capacity, operate bridge along the runway beams verifying that the bridge speed is provided as specified. Further, verify that the bridge stops in each direction within a distance (in feet) equal to 10 percent of rated capacity high speed (in feet per minute) when initially traveling at high speed and carrying the rated capacity load.
4. Record voltage, amperage, hoisting and lowering speeds, trolley travel speed, bridge travel speed, and motor speed for each motor.

END OF SECTION