Twin Falls Fire Station – 2

Twin Falls, Idaho

PROJECT MANUAL – SPECIFICATIONS FOR 100% Bid Set

VOLUME- 2 OF 2

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SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Escutcheons.
3. Grout.
4. Equipment installation requirements common to equipment sections.
5. Painting and finishing.
6. Concrete bases.
7. Supports and anchorages.

B. Related Sections

1. Section 230500 “Common Work Results for HVAC”

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, 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.

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

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 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 Fire-Suppression 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.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression 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. Provide and install access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels to be metal hinged with key lock.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 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 21 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. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

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

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

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

2.5 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 21 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, stamped-steel type.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw or spring clips.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using weatherproof caulk, matching building color.

N. 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 07.

O. Verify final equipment locations for roughing-in.

P. 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 21 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. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

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

3.3 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 (100 mm) 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 (450-mm) 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 (20.7-MPa), 28-day compressive-strength concrete and reinforcement.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

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

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

3.5 GROUTING

A. Mix and install grout for fire-suppression 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 210500

SECTION 21 11 19 - FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Wall-type fire-department connections as detailed on drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

PART 2 - PRODUCTS

2.1 WALL-TYPE FIRE-DEPARTMENT CONNECTION

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Elkhart Brass Mfg. Company
2. Fire-End & Croker Corp
3. Fire Protection Products
4. GMR International Equipment Corp
5. Guardian Fire Equipment
6. Potter Roemer
7. Wilson & Cousins Inc

B. Standard: UL 405.

C. Type: Exposed.

D. Pressure Rating: 175 psig (1200 kPa) minimum.

E. Body Material: Corrosion-resistant metal.

F. 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.

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

H. Escutcheon Plate: Round, brass, walltype.

I. Outlet: Bottom or end, with pipe threads.

J. Number of Inlets: Per NFPA .

K. Escutcheon Plate Marking: Similar to "AUTO SPKR."

L. Finish: Rough Brass

M. Outlet Size: Per Code.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

3.2 INSTALLATION

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

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

END OF SECTION 211119

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:

1. Section 211119 "Fire-Department Connections" for exposed-, flush-, and yard-type fire-department connections.

1.3 DEFINITIONS

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

1.4 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.

1.5 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 NICET Level III, using performance requirements and design criteria indicated.

1. Available fire-hydrant flow test records can be obtained from Water Company.

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

1. 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.
    d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
    e. Office and Public Areas: Light Hazard.
    f. Other areas not listed per NFPA.

2. Minimum Density for Automatic-Sprinkler Piping Design, per NFPA:
3. Maximum Protection Area per Sprinkler: Per UL listing.
4. Total Combined Hose-Stream Demand Requirement: According to NFPA 13.

D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13.

1.6 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 NICET Level III technician responsible for their preparation.

D. Qualification Data: For qualified Installer and NICET Level III technician.

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

F. Fire-hydrant flow test report.

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

H. Field quality-control reports.

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

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

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

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

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

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

1.8 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. Hybrid Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5.

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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. Corcoran Piping System Co.
    c. National Fittings, Inc.
    d. Shurjoint Piping Products.
    e. Tyco Fire & Building Products LP.
    f. Victaulic Company.

2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. 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.
4. 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.

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

C. 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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. Victaulic Company.

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

C. Bronze Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fivalco Inc.
    b. Global Safety Products, Inc.
    c. Milwaukee Valve Company.

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

D. Iron Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. Fivalco Inc.
    c. Global Safety Products, Inc.
    d. Kennedy Valve; a division of McWane, Inc.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Pratt, Henry Company.
    h. Shurjoint Piping Products.
    i. Tyco Fire & Building Products LP.
    j. Victaulic Company.

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

E. Check Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AFAC Inc.
    b. American Cast Iron Pipe Company; Waterous Company Subsidiary.
    c. Anvil International, Inc.
    d. Clow Valve Company; a division of McWane, Inc.
    e. Crane Co.; Crane Valve Group; Crane Valves.
    f. Crane Co.; Crane Valve Group; Jenkins Valves.
    g. Crane Co.; Crane Valve Group; Stockham Division.
    h. Fire-End & Croker Corporation.
    i. Fire Protection Products, Inc.
    j. Fivalco Inc.
    k. Globe Fire Sprinkler Corporation.
    l. Groeniger & Company.
    m. Kennedy Valve; a division of McWane, Inc.
    n. Matco-Norca.
    o. Metraflex, Inc.
    p. Milwaukee Valve Company.
    q. Mueller Co.; Water Products Division.
    r. NIBCO INC.
    s. Potter Roemer.
    t. Reliable Automatic Sprinkler Co., Inc.
    u. Shurjoint Piping Products.
    v. Tyco Fire & Building Products LP.
    w. United Brass Works, Inc.
    x. Venus Fire Protection Ltd.
    y. Victaulic Company.
    z. Viking Corporation.
    aa. Watts Water Technologies, Inc.

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

F. Bronze OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Stockham Division.
    c. Milwaukee Valve Company.
    d. NIBCO INC.
    e. United Brass Works, Inc.

2. Standard: UL 262.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Bronze.
5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
    b. American Valve, Inc.
    c. Clow Valve Company; a division of McWane, Inc.
    d. Crane Co.; Crane Valve Group; Crane Valves.
    e. Crane Co.; Crane Valve Group; Jenkins Valves.
    f. Crane Co.; Crane Valve Group; Stockham Division.
    g. Hammond Valve.
    h. Milwaukee Valve Company.
    i. Mueller Co.; Water Products Division.
    j. NIBCO INC.
    k. Shurjoint Piping Products.
    l. Tyco Fire & Building Products LP.
    m. United Brass Works, Inc.
    n. Watts Water Technologies, Inc.

2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. Fivalco Inc.
    c. Global Safety Products, Inc.
    d. Kennedy Valve; a division of McWane, Inc.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Shurjoint Piping Products.
    h. Tyco Fire & Building Products LP.
    i. Victaulic Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Valves NPS 2 (DN 50) and Smaller:

    a. Valve Type: Ball or butterfly.
    b. Body Material: Bronze.
    c. End Connections: Threaded.

5. Valves NPS 2-1/2 (DN 65) and Larger:

    a. Valve Type: Butterfly.
    b. Body Material: Cast or ductile iron.

c. End Connections: Flanged, grooved, or wafer.

6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch and visual indicating device.

I. Indicator Posts:

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. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. American Valve, Inc.
c. Clow Valve Company; a division of McWane, Inc.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kennedy Valve; a division of McWane, Inc.
f. Mueller Co.; Water Products Division.
g. NIBCO INC.
h. Tyco Fire & Building Products LP.

2. Standard: UL 789.
3. Type: Horizontal for wall mounting.
4. Body Material: Cast iron with extension rod and locking device.
5. Operation: Wrench.

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.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Fire Protection Products, Inc.
b. United Brass Works, Inc.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Affiliated Distributors.
b. Anvil International, Inc.
c. Barnett.
d. Conbraco Industries, Inc.; Apollo Valves.
e. Fire-End & Croker Corporation.

f. Fire Protection Products, Inc.
g. Flowserve.
h. FNW.
i. Jomar International, Ltd.
j. Kennedy Valve; a division of McWane, Inc.
k. Kitz Corporation.
l. Legend Valve.
m. Metso Automation USA Inc.
n. Milwaukee Valve Company.
o. NIBCO INC.
p. Potter Roemer.
q. Red-White Valve Corporation.
r. Southern Manufacturing Group.
s. Stewart, M. A. and Sons Ltd.
t. Tyco Fire & Building Products LP.
u. Victaulic Company.
v. Watts Water Technologies, Inc.

D. Globe Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Fire Protection Products, Inc.
b. United Brass Works, Inc.

E. Plug Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Southern Manufacturing Group.

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.

3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AFAC Inc.
    b. Reliable Automatic Sprinkler Co., Inc.
    c. Tyco Fire & Building Products LP.

2. Standard: UL 1726.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 (DN 20).
6. End Connections: Threaded.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. National Fittings, Inc.
    c. Shurjoint Piping Products.
    d. Tyco Fire & Building Products LP.
    e. Victaulic Company.

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

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AGF Manufacturing Inc.
    b. Reliable Automatic Sprinkler Co., Inc.
    c. Tyco Fire & Building Products LP.
    d. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.

5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:

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. Elkhart Brass Mfg. Company, Inc.
    b. Fire-End & Croker Corporation.
    c. Potter Roemer.

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

D. Sprinkler Inspector's Test Fittings:

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. AGF Manufacturing Inc.
    b. Triple R Specialty.
    c. Tyco Fire & Building Products LP.
    d. Victaulic Company.
    e. Viking Corporation.

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

E. Adjustable Drop Nipples:

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. CECA, LLC.
    b. Corcoran Piping System Co.
    c. Merit Manufacturing; a division of Anvil International, Inc.

2. Standard: UL 1474.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.

6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

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. Fivalco Inc.
   b. FlexHead Industries, Inc.
   c. Gateway Tubing, Inc.

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

2.8 SPRINKLERS

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. AFAC Inc.
2. Globe Fire Sprinkler Corporation.
3. Reliable Automatic Sprinkler Co., Inc.
4. Tyco Fire & Building Products LP.
5. Venus Fire Protection Ltd.
6. Victaulic Company.
7. Viking Corporation.

B. 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.
4. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum.

C. 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.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.

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

1. Ceiling Mounting: Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:

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. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Viking Corporation.

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

2.9 ALARM DEVICES

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

B. Electrically Operated Alarm Bell:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
b. Notifier; a Honeywell company.
c. Potter Electric Signal Company.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 8-inch (200-mm) minimum- diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Water-Flow Indicators:

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. ADT Security Services, Inc.
b. McDonnell & Miller; ITT Industries.
c. Potter Electric Signal Company.
d. System Sensor; a Honeywell company.
e. Viking Corporation.
f. Watts Industries (Canada) Inc.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. 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.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

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. AFAC Inc.
    b. Barksdale, Inc.
    c. Detroit Switch, Inc.
    d. Potter Electric Signal Company.
    e. System Sensor; a Honeywell company.
    f. Tyco Fire & Building Products LP.
    g. United Electric Controls Co.
    h. Viking Corporation.

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

E. Valve Supervisory Switches:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
    b. Kennedy Valve; a division of McWane, Inc.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.

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

F. Indicator-Post Supervisory Switches:

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. Potter Electric Signal Company.
    b. System Sensor; a Honeywell company.

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

2.10 PRESSURE GAGES

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. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.
4. WIKA Instrument Corporation.

B. Standard: UL 393.

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

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

E. 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 Civil Documents.

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

3.3 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 210500.

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210500.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210500.

3.4 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. 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.

J. 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.

K. 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.

3.5 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.

3.6 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. Include pressure drop in calcs or use multiple 90°elbows.

3.7 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 Division 26.

3.8 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. 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.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain.

3.11 PIPING SCHEDULE

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

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

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

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

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:

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

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:

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

3.12 SPRINKLER SCHEDULE

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

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Semi-Recessed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Pendent, dry sprinklers or Sidewall, dry sprinklers.

5. Special Applications: Extended-coverage, and quick-response sprinklers where indicated.

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

1. Semi-recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
2. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 211313

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SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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. Escutcheons.
5. Grout.
6. Equipment installation requirements common to equipment sections.
7. Painting and finishing.
8. Concrete bases.
9. Supports and anchorages.
10. Access doors

B. Related Sections

1. Section 230500 “Common Work Results for HVAC”

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, 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.

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

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Escutcheons.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 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.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08. At minimum, provide metal keylock hinged access doors with frames.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

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

B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, 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.

2.4 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 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. Available Manufacturers:

    a. Calpico, Inc.
    b. Lochinvar Corp.

D. 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. Available Manufacturers:

    a. Perfection Corp.
    b. Precision Plumbing Products, Inc.
    c. Sioux Chief Manufacturing Co., Inc.
    d. Victaulic Co. of America.

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

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

2.6 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.

2.7 ACCESS DOORS

A. Provide metal, keylock, hinged door access panels at all equipment requiring access. Refer to Division 08.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 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.

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, stamped-steel type.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.

M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using grout.

N. Verify final equipment locations for roughing-in.

O. 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. 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.

E. 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.

F. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

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 not indicated.

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

C. Install 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 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 (100 mm) 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 (450-mm) 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 (20.7-MPa), 28-day compressive-strength concrete and reinforcement.

3.7 ERECTION OF SUPPORTS AND ANCHORAGES

A. Cut, fit, and place nailers, blocking, and anchorages to support, and anchor plumbing 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. Connect to wood joists as required by manufacturer. Do not screw hangers into bottom of joists. Spread load over several joists. Verify with manufacturer.

3.8 GROUTING

A. Mix and install grout for plumbing 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 22 05 00

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SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Bronze swing check valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

B. ASME Compliance:

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

1.6 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 ball and plug valves open to minimize exposure of functional surfaces.
4. 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.

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 except plug valves.
3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:

1. 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.

F. Valve-End Connections:

1. Solder Joint: With sockets according to ASME B16.18.
2. Threaded: With threads according to ASME B1.20.1.

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

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless Steel Trim:

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. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Lance Valves; a division of Advanced Thermal Systems, Inc.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel.
j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.

e. Ends: Threaded.
f. Disc: PTFE or TFE.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 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.

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 valves.
2. Throttling Service: ball valves.
3. Pump-Discharge Check Valves:

a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with nonmetallic disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, with the following end connections:

1. For Copper Tubing, NPS 3 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

END OF SECTION 220523

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. Steel pipe hangers and supports.
2. Metal framing systems.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.

1.3 DEFINITIONS

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment per IBC and SMACNA.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Pipe positioning systems.

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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers:

1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.
4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Available Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

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

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

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 PIPE POSITIONING SYSTEMS

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

B. Available Manufacturers:

1. C & S Mfg. Corp.
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.

2.6 EQUIPMENT SUPPORTS

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

2.7 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

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

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

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

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of insulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of insulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of insulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of insulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (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.

G. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
2. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
3. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
4. 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 (680 kg).

5. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

H. Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

J. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

3.2 HANGER AND SUPPORT INSTALLATION

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

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

C. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

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

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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. Install lateral bracing with pipe hangers and supports to prevent swaying.

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

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

J. 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 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

4. Pipes NPS 4 and Larger: Include inserts.
5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

A. Touch 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 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 220529

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.3 ACTION SUBMITTALS

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

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

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

D. Valve numbering scheme.

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

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. Brady Corporation.
b. Brimar Industries, Inc.
c. Carlton Industries, LP.
d. Champion America.
e. Craftmark Pipe Markers.
f. emedco.

g. Kolbi Pipe Marker Co.
h. LEM Products Inc.
i. Marking Services, Inc.
j. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: Blue.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
7. Minimum Letter Size: 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-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPE LABELS

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. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Sevices Inc.
11. Seton Identification Products.

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

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

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

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

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. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Sevices Inc.
11. Seton Identification Products.

B. 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) stainless steel, 0.025-inch (0.64-mm) aluminum, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain or S-hook.

C. 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 GENERAL INSTALLATION REQUIREMENTS

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

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

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

3.3 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. 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 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 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

1. Low-Pressure Compressed Air Piping:

   a. Background: Safety blue.
   b. Letter Colors: White.

2. Domestic Water Piping

   a. Background: Safety green.
   b. Letter Colors: White.

3. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Safety purple.
   b. Letter Color: Black.

3.5 VALVE-TAG INSTALLATION

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

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

1. Valve-Tag Size and Shape:

    a. Cold Water: 1-1/2 inches (38 mm), round.
    b. Hot Water: 1-1/2 inches (38 mm), round.
    c. Low-Pressure Compressed Air: 1-1/2 inches (38 mm), round.

2. Valve-Tag Colors:

    a. Cold Water: Natural.
    b. Hot Water: Safety green.
    c. Low-Pressure Compressed Air: Safety blue.

3. Letter Colors:

    a. Cold Water: White.
    b. Hot Water: White.
    c. Low-Pressure Compressed Air: White.

END OF SECTION 220553

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Mineral fiber.

2. Factory applied jackets.
3. Field-applied jackets.
4. Tapes.

B. Related Sections include the following:

1. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per 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 and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 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 piping insulation application and equipment Installer for equipment 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.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. 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 Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000(Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. 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-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 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.

2.3 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. 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.

2.4 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following]:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.5 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

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.

1. Verify that systems and equipment 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.

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 equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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 4 inches (100 mm) o.c.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

J. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

K. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

L. 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.

M. 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 Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

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, 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.

3.6 MINERAL-FIBER INSULATION INSTALLATION

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 but 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.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC fitting covers are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended method.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 6 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:

1. Insulation shall be the following:

a. 1” and smaller: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
b. 1-1/4” and larger: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2” thick.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Piping, Concealed:

1. PVC fitting covers.

B. Piping, Exposed:

1. PVC fitting covers.

END OF SECTION 220700

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Specialty valves.
3. Escutcheons.

B. Related Section:

1. Civil plans and specifications for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

1.4 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Backflow preventers
3. Escutcheons.

B. Water Samples: Specified in "Cleaning" Article.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L & K water tube, drawn temper.

1. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
3. 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.

2.3 PIPING JOINING MATERIALS

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

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

2.4 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Calpico, Inc.
b. Lochinvar Corporation.

2. Description:

a. Galvanized-steel coupling.
b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
c. End Connections: Female threaded.
d. Lining: Inert and noncorrosive, thermoplastic.

C. Dielectric Nipples:

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. Perfection Corporation; a subsidiary of American Meter Company.
b. Precision Plumbing Products, Inc.
c. Victaulic Company.

2. Description:

a. Electroplated steel nipple complying with ASTM F 1545.
b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
c. End Connections: Male threaded or grooved.
d. Lining: Inert and noncorrosive, propylene.

2.6 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates in accordance with 220500.

2.7 GROUT

A. Standard: ASTM C 1107, 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 EARTHWORK

A. Comply with requirements in civil plans for excavating, trenching, and backfilling. At minimum, provide 6” sand bed below and above piping prior to backfill with native soil.

3.2 PIPING INSTALLATION

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

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

C. Install underground copper tube in 2 layers skotch wrap or 6 mil poly sleeve with joints taped.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

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

G. 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.

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

I. Install piping adjacent to equipment and specialties to allow service and maintenance.

J. Install piping to permit valve servicing.

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

L. Install piping free of sags and bends.

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

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

O. Install time clock and required sensors in hot-water circulation piping

3.3 JOINT CONSTRUCTION

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

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

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

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

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

E. Soldered Joints: 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."

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 (DN 50) and smaller.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 (DN 50) and smaller. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.5 DIELECTRIC FITTING INSTALLATION

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

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

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

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 or band 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 per MSS SP-69

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

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

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

3.7 CONNECTIONS

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

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.8 ESCUTCHEON INSTALLATION

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

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, stamped steel with set screw or spring clips.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, stamped steel with set screw.
4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw.
5. Bare Piping in Equipment Rooms: One piece, stamped steel with set screw or spring clips.

3.9 SLEEVE INSTALLATION

A. 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 in Division 07 for firestop materials and installations.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. 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:

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

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

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. 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.
3. 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.
4. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
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 for corrective action required.

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

E. Prepare test and inspection reports.

3.11 ADJUSTING

A. Perform the following adjustments before operation:

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

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water 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. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 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. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

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

3.13 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. Under-building-slab, domestic water, building service piping, NPS 6 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A; wrought-copper solder-joint fittings; and brazed joints. Run in 6 mil poly sleeve.

E. Aboveground domestic water piping, NPS 6 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B; wrought- copper solder-joint fittings; and solder joints.

3.14 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 ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated or Memory-stop 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.

END OF SECTION 221116

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Backflow preventers.
2. Balancing valves.
3. Temperature-actuated water mixing valves.
4. Strainers.
5. Outlet boxes.
6. Wall hydrants.
7. Drain valves.
8. Water hammer arresters.
9. Air vents.
10. Trap-seal primer valves.

1.3 PERFORMANCE REQUIREMENTS

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

1.4 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties 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. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Double-Check Backflow-Prevention Assemblies:

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. Ames Co.
    b. Conbraco Industries, Inc.
    c. FEBCO; SPX Valves & Controls.
    d. Flomatic Corporation.
    e. Watts Industries, Inc.; Water Products Div.
    f. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 (DN 50) and smaller; stainless steel for NPS 2-1/2 (DN 65) and larger.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

2.2 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

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. Armstrong International, Inc.
    b. Flo Fab Inc.
    c. ITT Industries; Bell & Gossett Div.
    d. NIBCO INC.
    e. TAC Americas.
    f. Taco, Inc.
    g. Watts Industries, Inc.; Water Products Div.
    h.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Bronze.
4. Size: Same as connected piping, but not larger than NPS 2 (DN 50).

B. Memory-Stop Balancing Valves:

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. Conbraco Industries, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; Stockham Div.
    e. Hammond Valve.
    f. Milwaukee Valve Company.
    g. NIBCO INC.
    h. Red-White Valve Corp.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
4. Size: NPS 2 (DN 50) or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.3 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

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. Armstrong International, Inc.
    b. Cash Acme.
    c. Conbraco Industries, Inc.
    d. Honeywell Water Controls.
    e. Legend Valve.
    f. Leonard Valve Company.
    g. Powers; a Watts Industries Co.
    h. Symmons Industries, Inc.
    i. Taco, Inc.
    j. Watts Industries, Inc.; Water Products Div.
    k. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (860 kPa).
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.

6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Rough bronze.

B. Individual-Fixture, Water Tempering Valves:

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. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company.
   f. Powers; a Watts Industries Co.
   g. Watts Industries, Inc.; Water Products Div.
   h. Zurn Plumbing Products Group; Wilkins Div.

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: Rough or chrome-plated bronze.

2.4 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.
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. Drain: Pipe plug.

2.5 OUTLET BOXES

A. Icemaker Outlet Boxes:

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. Acorn Engineering Company.
   b. IPS Corporation.
   c. LSP Products Group, Inc.
   d. Oatey.
   e. Plastic Oddities; a division of Diverse Corporate Technologies.

2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 (DN 15) ball valve and NPS 1/2 (DN 15) copper, water tubing.

2.6 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

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. Josam Company.
    b. MIFAB, Inc.
    c. Prier Products, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products Inc.
    g. Woodford Manufacturing Company.
    h. Zurn Plumbing Products Group; Light Commercial Operation.
    i. Zurn Plumbing Products Group; Specification Drainage Operation.

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: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Nozzle and Wall-Plate Finish: Rough bronze.
9. Operating Keys(s): Two with each wall hydrant.

2.7 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.

2.8 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

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. AMTROL, Inc.
    b. Josam Company.
    c. MIFAB, Inc.
    d. PPP Inc.
    e. Sioux Chief Manufacturing Company, Inc.
    f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    g. Tyler Pipe; Wade Div.
    h. Watts Drainage Products Inc.
    i. Zurn Plumbing Products Group; Specification Drainage Operation.

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

2.9 TRAP-SEAL PRIMER VALVES

A. Note: As first choice, use tailpiece primer off nearest flush valve. If not available use the following with hinged metal key lock access panel: Coordinate location with architect.

B. Supply-Type, Trap-Seal Primer Valves:

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. MIFAB, Inc.
    b. PPP Inc.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1018. Adjustable.
3. Pressure Rating: 125 psig (860 kPa) minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

C. Drainage-Type, Trap-Seal Primer Valves:

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. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 (DN 10) minimum, trap makeup connection.
3. Size: NPS 1-1/4 (DN 32) minimum.
4. Material: Chrome-plated, cast brass.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. 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 not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

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

D. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06.

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

F. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

G. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

H. Install access panels in locations needed for access to equipment, valves, etc. Coordinate with Architect and room finishes.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26.

C. Connect wiring according to Division 26.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.4 ADJUSTING

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

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

END OF SECTION 221119

SECTION 22 11 23 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.

1.3 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.

1.4 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.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

B. Protect bearings and couplings against damage.

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

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Corporation.
3. Grundfos Pumps Corp.
4. TACO Incorporated.
5. WILO USA LLC - WILO Canada Inc.

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.

D. Capacities and Characteristics: As scheduled on drawings.

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.

2.3 CONTROLS

A. Timers: Wire pump and coordinate with electrical. Provide Aquastat and timer to control pump. If in building occupied mode per timer and Aquastat is below setpoint pump shall run. If unoccupied pump shall be off.

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 and j-box on top unless otherwise indicated.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "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.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set 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.

3.5 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 221123

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. NBR: Acrylonitrile-butadiene rubber.

C. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.6 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 MANUFACTURERS

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS

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

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 and CISPI 301.

B. Approved Manufacturers:

1. AB&I
2. Charlotte
3. Tyler

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

a. Available Manufacturers:

1) ANACO.
2) Fernco, Inc.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.

2.4 ABS PIPE AND FITTINGS

A. Solid core ABS Pipe: Schedule 40

B. ABS Socket Fittings: ASTM D2661 DWV patterns

C. Solvent Cement and Adhesive primer per manufacturing

2.5 PVC PIPE AND FITTINGS

A. Solid Core PVC Pipe: Schedule 40

B. PVC Socket Fittings in DWV Pattern

C. Solvent cement and primer per manufacturer requirements.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Civil plans and specifications for excavating, trenching, and backfilling. At minimum, provide 6” sand bed above and below piping prior to backfill with native soil.

3.2 PIPING APPLICATIONS

A. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be the following:

1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

B. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

C. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be the following:

1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

D. Aboveground, vent piping NPS 5 (DN 125) and larger shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

E. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
2. Solid Core ABS or PVC with solvent cement DWV fittings

F. Underground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
2. Solid Core ABS or PVC with solvent cement DWV fittings.

3.3 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in civil drawings. .

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install seismic restraints on piping.

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

F. 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.

G. 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.

H. 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.

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

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

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 cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters per MSS SP-69:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm).
2. NPS 3 (DN 80): 60 inches (1500 mm).
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm).
4. NPS 6 (DN 150): 60 inches (1500 mm).

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

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.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. 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. 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.

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.

END OF SECTION 221316

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Miscellaneous sanitary drainage piping specialties.
5. Flashing materials.

B. Related Sections include the following:

1. Division 22 Section "Storm Drainage Piping Specialties" for roof drains.

1.3 SUBMITTALS

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

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

1.5 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

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. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

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

B. Metal Floor Cleanouts:

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. Josam Company; Josam Div.
b. Oatey.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group; Light Commercial Operation.
h. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing or threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing or Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Inside calk, Threaded.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
10. Frame and Cover Material and Finish: Polished bronze.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Light Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

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. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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. Commercial Enameling Co.
    b. Josam Company; Josam Div.
    c. MIFAB, Inc.
    d. Prier Products, Inc.
    e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    f. Tyler Pipe; Wade Div.
    g. Watts Drainage Products Inc.
    h. Zurn Plumbing Products Group; Light Commercial Operation.
    i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom, Side.
9. Top or Strainer Material: Bronze.
10. Top of Body and Strainer Finish: Polished bronze.
11. Top Shape: Round.
12. Top Loading Classification: Light Duty.
13. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
14. Trap Material: Cast iron.
15. Trap Pattern: Standard P-trap.
16. Trap Features: Trap-seal primer valve drain connection.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch- (2.4-mm-) thick, lead flashing collar and skirt extending at least 6 inches (150 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

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

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

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

1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).
2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm thickness).

C. 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.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

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

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

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. 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.

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 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 drainage area radii per ADA:
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.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

J. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

K. Install vent caps on each vent pipe passing through roof.

L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

M. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 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 pipe size, with minimum length of 10 inches (250 mm), and 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. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07.

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 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 221319

SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water (30 kPa).

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.6 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 MANUFACTURERS

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS

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

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 and CISPI 301.

B. Approved Manufacturers:

1. AB&I
2. Charlotte
3. Tyler

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

a. Available Manufacturers:

1) ANACO.
2) Fernco, Inc.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.

2.4 ABS PIPE AND FITTINGS

A. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

B. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

C. Solvent Cement and Adhesive Primer:

1. Use ABS solvent cement that has a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 PVC PIPE AND FITTINGS

A. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

B. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

C. Solvent Cement and Adhesive Primer:

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Civil plans and specifications for excavating, trenching, and backfilling. At minimum, provide 6” sand bed above and below pipe prior to backfill with native soil.

3.2 PIPING APPLICATIONS

A. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and coupled joints.

B. Underground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and coupled joints.
2. Cellular-core ABS pipe, ABS socket fittings, and solvent-cemented joints.
3. Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in civil drawings.

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

F. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

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

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 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

J. Install ABS storm drainage piping according to ASTM D 2661.

K. Install PVC storm drainage piping according to ASTM D 2665.

L. Install underground ABS and 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. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. ABS and PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." 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 (30 m) and Less: MSS Type 1, adjustable, steel or band clevis hangers.

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 cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters, per MSS SP-69:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm).
2. NPS 3 (DN 80): 60 inches (1500 mm).
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm).
4. NPS 6 (DN 150): 60 inches (1500 mm).

3.6 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.

3.7 FIELD QUALITY CONTROL

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

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

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

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

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

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). 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.

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.

END OF SECTION 221413

SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Roof and overflow drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Flashing materials.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 ROOF AND OVERFLOW DRAINS

A. Cast-Iron, Large-Sump, General-Purpose Roof/Overflow Drains:

1. Manufacturers: Subject to compliance with requirements, [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Josam Company.
b. Marathon Roofing Products.
c. MIFAB, Inc.
d. Smith, Jay R. Mfg. Co.
e. Tyler Pipe.
f. Watts Water Technologies, Inc.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.4, for general-purpose roof drains.

3. Body Material: Cast iron.
4. Flashing Ring: Required.
5. Outlet: Bottom, Side.
6. Extension Collars: Required on overflows.
7. Underdeck Clamp: Required.
8. Sump Receiver Plate: Required.
9. Dome Material: Cast iron.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Conductor Nozzles:

1. Description: Stainless steel body with threaded inlet and wall flange and hinged perforated outlet grate.
2. Size: Same as connected conductor.

2.3 CLEANOUTS

A. Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Josam Company.
    b. Oatey.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Smith, Jay R. Mfg. Co.
    e. Tyler Pipe.
    f. Watts Water Technologies, Inc.
    g. Zurn Plumbing Products Group; Light Commercial Products Operation.
    h. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M, for cast-iron soil pipe with cast-iron ferrule and threaded, adjustable housing cleanouts.
3. Size: Same as connected branch.
4. Type: Cast-iron soil pipe with cast-iron ferrule and Threaded, adjustable housing.
5. Body or Ferrule Material: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Inside calk Threaded.
8. Closure: Brass plug with tapered threads or Cast-iron plug.
9. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
10. Frame and Cover Material and Finish: Polished bronze.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Light Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.
d. Tyler Pipe.
e. Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass or cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, wall-installation frame and cover.

2.4 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. Roofing materials are specified in Division 07 Sections.

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 conductor nozzles at exposed bottom of conductors where they spill onto grade. Remove screws from grate.

C. 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.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Sections. 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 22 14 23

SECTION 22 15 13 - GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig (1380 kPa) or less.

1.2 DEFINITIONS

A. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig (1035 kPa) or less.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Flexible pipe connectors.
3. Pressure regulators. Include rated capacities and operating characteristics.
4. Filters. Include rated capacities and operating characteristics.
5. Hose assemblies.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For general-service compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

B. ASME Compliance:

1. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.

1. Steel Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.

B. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B) seamless, drawn-temper, water tube.

1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
2. Copper Unions: ASME B16.22 or MSS SP-123.

C. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 JOINING MATERIALS

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

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

2.3 VALVES

A. Metal Ball Valves: Comply with requirements in Section 220523" Valves for Plumbing Piping,"

2.4 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. HART Industrial Unions, LLC.
d. Jomar Valve.
e. Matco-Norca.
f. McDonald, A.Y. Mfg Co.
g. WATTS.
h. Wilkins.

2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.5 FLEXIBLE PIPE CONNECTORS

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

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Hyspan Precision Products, Inc.
4. Mercer Rubber Co.
5. Metraflex Company (The).
6. Proco Products, Inc.
7. Unaflex.
8. Universal Metal Hose.

B. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: 200 psig (1380 kPa) minimum.
2. End Connections, NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections, NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

2.6 SPECIALTIES

A. Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig (1380-kPa) minimum inlet pressure, unless otherwise indicated.

B. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated.

2.7 HOSE ASSEMBLIES

A. Refer to drawings for make and model.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller: Schedule 40, black galvanized-steel pipe; threaded, malleable-iron fittings; and threaded joints.
2. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed or soldered joints.

B. Drain Piping: Use one of the following piping materials:

1. NPS 2 (DN 50) and Smaller: Type M (Type C) copper tube; wrought-copper fittings; and brazed or soldered joints.

3.2 VALVE APPLICATIONS

A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Articles in Section 220523 "Valves for Plumbing Piping," according to the following:

1. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
2. Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.3 PIPING INSTALLATION

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

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

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

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

E. Install piping adjacent to equipment and machines to allow service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

H. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

I. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

J. Install piping to permit valve servicing.

K. Install piping free of sags and bends.

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

M. Install seismic restraints on piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500.

3.4 JOINT CONSTRUCTION

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

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

C. Threaded Joints: Thread pipe with tapered pipe threads 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.

D. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Section 220523 "Valves for Plumbing Piping,"

B. Install shutoff valves and unions at compressed-air piping to air compressors.

C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.

3.6 DIELECTRIC FITTING INSTALLATION

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

B. NPS 2 (DN 50) and Smaller: Use dielectric unions.

3.7 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge piping of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment.

D. Install automatic drain valves on receivers, and dryers. Discharge condensate onto nearest floor drain.

E. Install filters in compressed-air piping where shown.

F. Install nipple at piping terminals for hose connections.

G. Install hose assemblies at hose connections.

3.9 CONNECTIONS

A. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.10 HANGER AND SUPPORT INSTALLATION

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

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) or Less: MSS Type 1, adjustable, steel clevis or band hangers.

D. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

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

F. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 to NPS 1/2 (DN 8 to DN 15): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/4 to NPS 1-1/4 (DN 20 to DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

G. Install supports for vertical, Schedule 40, steel piping every 15 feet (4.6 m).

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

1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

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

3.11 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.12 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect filters and pressure regulators for proper operation.

C. Prepare test reports.

END OF SECTION 221513

SECTION 22 15 19 - GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Lubricated, reciprocating air compressors.
2. Inlet-air filters.
3. Refrigerated compressed-air dryers.

1.3 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm (actual L/s).

B. Standard Air: Free air at 68 deg F (20 deg C) and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm (standard L/s).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

B. Shop Drawings:

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

C. Delegated-Design Submittal: For compressed-air equipment mounting.

1. Detail fabrication and assembly of supports.
2. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air equipment to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Air-Compressor, Inlet-Air-Filter Elements: 2 units.
2. Belts: Two for each belt-driven compressor.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.3 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120-V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Instrumentation: Include discharge-air pressure gage, hour meter, and control transformer.

C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.

D. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.4 LUBRICATED, RECIPROCATING AIR COMPRESSORS

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. Atlas Copco.
2. CompAir, Ltd.
3. Curtis-Toledo.
4. Gardner Denver, Inc.
5. General Air Products, Inc.
6. Ingersoll-Rand.
7. Kaeser Compressors, Inc.
8. Powerex, Inc.
9. Quincy Compressor.
10. Saylor-Beall Manufacturing Company.

B. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.

1. Submerged gear-type oil pump.
2. Oil filter.

3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
4. Belt guard totally enclosing pulleys and belts.

C. Capacities and Characteristics: As scheduled on drawings.

2.5 REFRIGERANT COMPRESSED-AIR DRYERS

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. Air/Tak, Inc.
2. Arrow Pneumatics, Inc.
3. Atlas Copco.
4. Curtis-Toledo.
5. Domnick Hunter Limited.
6. Donaldson Company, Inc.
7. Hankison International.
8. Ingersoll-Rand.
9. Kaeser Compressors, Inc.
10. McIntire Company.
11. Numatics, Incorporated.
12. Pioneer Air Systems, Inc.
13. Pneumatech Inc.
14. SPX Air Treatment.
15. Van Air Systems, Inc.
16. Wilkerson Operations.
17. Zeks Compressed Air Solutions.

B. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F (2 deg C), 100-psig (690-kPa) air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

C. Capacities and Characteristics: Match compressor output

2.6 MOTORS

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

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

2.7 AUTO DRAIN

A. Provide 120v timer initiated autodrain on receiver, coordinate power requirement with electrical contractor and pipe waste to drain

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Equipment Mounting:

1. Install air compressors and air dryers on cast-in-place concrete equipment base(s).
2. Mount compressor on 1” waffle isolation pad and secure with seismic restraints.

B. Install compressed-air equipment anchored to substrate.

C. Arrange equipment so controls and devices are accessible for servicing.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Install the following devices on compressed-air equipment:

1. Pressure Regulators: Install downstream from air compressors and dryers.
2. Automatic Drain Valves: Install on receivers, and dryers. Discharge condensate over nearest floor drain.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221513 "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to machine, allow space for service and maintenance.

3.3 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air-compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure, but not higher than rating of system components.
7. Check for proper seismic restraints.
8. Drain receiver tanks.
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air compressors and air dryers.

END OF SECTION 221519

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 22 Sections apply to this Section:

1. Common Work Results for Plumbing.

1.2 SUMMARY

A. This Section includes plumbing fixtures and trim, fittings and accessories, appliances, appurtenances, equipment and supports associated with plumbing fixtures.

B. Products furnished but not installed under this Section include:

1. Plumbing fittings (including faucets) and piping indicated for fixtures, appliances, appurtenances and equipment provided by Owner.
2. Plumbing fittings (including faucets) and piping indicated for fixtures, appliances, appurtenances and equipment specified in other sections. All fittings/faucets shall be lead free per NSF 61, App G, AB1953.

C. Products installed but not furnished under this Section include:

1. Owner supplied fixtures, as indicated.
2. Accessories, appliances, appurtenances and equipment specified in other sections requiring plumbing services or fixture-related devices, as indicated.

1.3 DEFINITIONS

A. Accessible: Describes a plumbing fixture, building, facility or portion thereof that can be approached, entered and used by physically handicapped people.

B. Accessory: Device that adds effectiveness, convenience or improved appearance to a fixture but is not essential to its operation.

C. Appliance: Device or machine designed and intended to perform a specific function.

D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.

E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.

F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.

G. Fixture: Installed receptor connected to the water distribution system that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor except when used in a

general application where terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support and equipment.

H. Roughing In: Installation of piping and support for the fixture prior to the actual installation of the fixture.

I. Support: Device normally concealed in building construction for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:

1. Chair Carrier: Support for wall hung fixture having steel pipe uprights that transfer weight to the floor.
2. Chair Carrier, Heavy Duty: Support for wall hung fixture having rectangular steel uprights that transfer weight to the floor.
3. Reinforcement: Wood blocking or steel plate built into wall construction for securing fixture to wall.

J. Trim: Hardware and miscellaneous parts specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1. Product data for each type of plumbing fixture specified including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components and finishes.
2. Wiring diagrams for field installed wiring of electrically-operated units.

1.5 QUALITY ASSURANCE

A. ADA Requirements: Comply with requirements of Americans with Disability Act. Provide fixtures complying with ADA accessibility requirements.

B. Regulatory Requirements: Comply with requirements of ANSI Standard A117.1 "Buildings and Facilities Providing Accessibility and Usability for Physically Handicapped People" and Public Law 90 480 "Architectural Barriers Act, 1968" with respect to plumbing fixtures for the physically handicapped.

C. Regulatory Requirements: Comply with requirements of ATBCB (Architectural and Transportation Barriers Compliance Board) "Uniform Federal Accessibility Standards (UFAS) 1985 494 187" with respect to plumbing fixtures for the physically handicapped.

D. Listing and Labeling: Provide electrically-operated fixtures specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations

in dimensions, operation, color or finish or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixtures is on the proposer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver plumbing fixtures in manufacturer's protective packing, crating and covering.

B. Store plumbing fixtures on elevated platforms in a dry location.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

1. Water Closets:

   a. American Standard, Inc.
   b. Kohler Co.
   c. Eljer
   d. Crane

2. Lavatories:

   a. American Standard, Inc.
   b. Crane Plumbing/Fiat Products.
   c. Eljer; A Household International Co.
   d. Kohler Co.

3. Sinks:

   a. Elkay Manufacturing Co.
   b. Just Manufacturing Co.

4. Service Sinks:

   a. American Standard, Inc.
   b. Kohler Co.
   c. Eljer

5. Emergency Equipment:

   a. Bradley Corp.
   b. Encon.
   c. Guardian Equipment.
   d. Haws Drinking Faucet Co.
   e. Speakman Co.
   f. Water Saver Faucet Co.
   g. Western Drinking Fountains; Sunroc Corp.

6. Toilet Seats:

   a. Bemis Mfg. Co.

b. Beneke Div.; Sanderson Plumbing Products, Inc.
c. Church Seat Co.
d. Kohler Co.
e. Olsonite Corp.
f. Sperzel Industries, Inc.

7. Flushometers:

a. Sloan Valve Co.

8. Commercial/Industrial Cast Brass Faucets:

a. American Standard, Inc.
b. Chicago Faucet Co.
c. Delta Faucet Co.; Div. of Masco Corp.
d. Kohler Co.
e. Symmons Industries, Inc.
f. T & S Brass and Bronze Works, Inc.

9. Water Heaters

a. AO Smith
b. Rheem
c. Ruud
d. Bradford White

10. Supports:

a. Ancon, Inc.
b. Josam Co.
c. Smith (Jay R.) Mfg. Co.
d. Wade Div.; Tyler Pipe.
e. Zurn Industries, Inc.; Hydromechanics Div.

2.2 PLUMBING FIXTURES, GENERAL

A. Provide plumbing fixtures and trim, fittings, other components and supports as specified.

2.3 FAUCETS

A. Faucets, General: Unless otherwise specified, provide faucets that are cast-brass with polished chrome-plated finish.

2.4 FITTINGS, EXCEPT FAUCETS

A. Fittings, General: Unless otherwise specified, provide fittings fabricated of brass with a polished chrome-plated finish.

B. Lavatory Supplies and Stops: 1/4 turn ball type angle stop having 1/2" NPS inlet with wall flange and 3/8" by 12" flexible chrome plated copper tubing riser outlet.

C. Lavatory Traps: Cast brass, 1 1/4" NPS adjustable P-trap with cleanout, 17-gauge tubular waste to wall and wall flange.

D. Sink Supplies and Stops: 1/4 turn ball type angle stop having 1/2" NPS inlet with wall flange and 1/2" by 12" flexible chrome plated copper tubing riser outlet.

E. Sink Traps: Cast brass, 1-1/2" NPS adjustable P-trap with cleanout, 17-gauge tubular waste to wall and wall flange.

F. Sink Continuous Wastes: Polished chrome plated, tubular brass, 11/2", 17 gauge, with brass nuts on slip inlets and of configurations indicated.

G. Supply and drain plumbing service fittings not listed above shall be as specified and as scheduled.

H. Fittings installed concealed inside a plumbing fixture or within wall construction may be without chrome-plate finish.

I. Escutcheons: Wall flange with set screw.

J. Escutcheons: Polished chrome plated, sheet steel wall flange with friction clips.

K. Deep Pattern Escutcheons: Wall flange with set screw or sheet-steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

L. Provide fittings specified as part of a fixture description in lieu of fitting requirements above.

2.5 FLUSHOMETERS

A. Provide flushometers compatible with fixtures with features and of consumption indicated.

B. Construction: Cast brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, vacuum breaker and brass lever handle actuation except where other variations are specified. Type shall be diaphragm operation except where other type is specified.

C. Finish: Exposed metal parts shall be polished chrome plated except components installed in a concealed location may be rough brass or unfinished.

D. Flushometers: Furnish with following features:

1. Non hold open feature.
2. ADA actuator on handicapped fixtures mounted on wide side of fixture.
3. Seat bumper on stop.
4. Trap primer connection.
5. Furnish flushometers with factory set or field adjusted maximum water consumption to match fixture

2.6 TOILET SEATS

A. General: Provide toilet seats compatible with water closets of type, color and features indicated.

B. Toilet Seats: Extra heavy-duty, commercial/industrial type, elongated, open front, solid plastic, with check hinge.

2.7 PLUMBING FIXTURE SUPPORTS

A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified and wall reinforcement.

B. Support categories are:

1. Chair Carriers: Supports with steel pipe uprights for wall-hanging fixtures. Urinal chair carriers shall have bearing plates.
2. Chair Carriers, Heavy Duty: Supports with rectangular steel uprights for wall-hanging fixtures.
3. Reinforcement: 2" by 4" wood blocking between studs or 1/4" by 6" steel plates attached to studs in wall construction to secure floor-mounted and special fixtures to wall.

C. Support Types: Provide support of category specified of type having features required to match fixture.

D. Provide supports specified as part of fixture description in lieu of category and type requirements above.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing in for potable cold water and hot water supplies and soil, waste and vent piping systems to verify actual locations of piping connections prior to installing fixtures.

B. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Install plumbing fixtures and specified components in accordance with designations and locations indicated on drawings.

B. Install supports for plumbing fixtures in accordance with categories indicated and of type required.

1. Chair carriers for the following fixtures:

   a. Wall hanging lavatories and sinks.

2. Heavy-duty chair carriers for the following fixtures:

   a. Fixtures where specified.

3. Reinforcement for the following fixtures:

   a. Fixtures required to be secured to wall.

3.3 INSTALLATION OF PLUMBING FIXTURES

A. Install plumbing fixtures level and plumb in accordance with fixture manufacturers' written installation instructions, roughing-in drawings and referenced standards.

B. Install floor mounted; floor outlet water closets with closet flanges and gasket seals.

C. Install wall hanging, back outlet urinals with gasket seals.

D. Fasten wall hanging plumbing fixtures securely to supports attached to building substrate when supports are specified and to building wall construction where no support is indicated.

E. Fasten floor mounted fixtures and special fixtures having holes for securing fixture to wall construction to reinforcement built into walls.

F. Fasten wall mounted fittings to reinforcement built into walls.

G. Fasten counter mounting type plumbing fixtures to casework.

H. Secure supplies behind wall or within wall pipe space, providing rigid installation.

I. Install stop valve in an accessible location in each water supply to each fixture.

J. Install trap on fixture outlet except for fixtures having integral trap.

K. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.

L. Seal fixtures to walls, floors and counters using a sanitary type, one-part, mildew-resistant, silicone. Match sealant color to fixture color.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The drawings indicate general arrangement of piping, fittings and specialties. The following are specific connection requirements:

1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 15.
2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings and controls.

B. Adjust water pressure at, faucets, and flushometers having controls to provide proper flow and stream.

C. Replace washers of leaking and dripping faucets and stops.

D. Clean fixtures, fittings and spout and drain strainers with manufacturers' recommended cleaning methods and materials.

E. Review the data in Operating and Maintenance Manuals. Refer to Division 1.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities except when approved in writing by the Owner.

END OF SECTION 224000

SECTION 23 05 00 - COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. All drawings associated with the entire project, including general provisions of the Contract, including The General Conditions of the Contract for Construction, General and Supplementary Conditions and Division-1 Conditions specification sections shall apply to the Division 21, 22, and 23 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with the aforementioned and all other Contract Documents associated with the project.

B. Related Sections: Refer to all sections in Division 21, 22, and 23. Refer to Division 26 specification sections and Division 26 drawings.

C. Where contradictions occur between this section and Division 1, the more stringent requirement shall apply.

D. Contractor shall be defined as any and all entities involved with the construction of the project.

1.2 SUMMARY:

A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Divisions 21, 22, and 23. It expands and supplements the requirements specified in Division 1.

1.3 MECHANICAL INSTALLATIONS:

A. The Contract Documents are diagrammatic, showing certain physical relationships which must be established within the mechanical work and its interface with all other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.

B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.

C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, Contractor shall take the necessary measurements and prepare the drawings.

D. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.

E. The contract documents indicate required size and points of terminations of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. It is not intended that drawings indicate necessary offsets. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.

F. Before any work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as intended without interferences between systems, structural elements or work of other trades.

G. Verify all dimensions by field measurements.

H. Coordinate installation in chases, slots and openings with all other building components to allow for proper mechanical installations.

I. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

J. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

K. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

L. Make allowance for expansion and contraction for all building components and piping systems that are subject to such.

M. The ceiling space shall not be “layered”. It is the contractor’s responsibility to offset and system as required to allow installation within the identified ceiling cavity. The contractor shall include labor and material in the base bid to accommodate such offsets.

N. In general, all “static” piping systems shall be routed as high as possible, i.e. fire protection systems. Keep all equipment in accessible areas such as corridors and coordinate with systems and equipment from other sections.

O. The Contractor shall provide all labor and material necessary but not limited to the starting/stopping of all mechanical equipment, opening/closing of all valves, draining/refilling all mechanical systems and operating/verifying the operation of all mechanical systems controls as required to accomplish all work necessary to meet construction document requirements. Contractor shall submit records of such activities to engineer and include in the O & M manuals.

1.4 COORDINATION:

A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for coordination all or the work, in all areas. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, isolation valves, offsets, hangers, control devices, etc., necessary to overcome congested conditions at no increase in contact sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts. Increases to contract sum or schedule shall not be considered for such effort.

B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project. Coordination shall include, but not be limited to the following:

1. Fire Protection and Fire Alarm Contractor shall provide shop drawings to all other Division 21 and 23 Contractors.
2. Automatic Temperature Controls, Building Management and Testing, Adjusting and Balancing Contractors shall be provided with equipment product data and shop drawings

from other Division 21, 22, 23 and 26 Contractors and shall furnish the same information involving control devices to the appropriate Division 21, 22, and 23 Contractor.

1.5 COORDINATION WITH OTHER DIVISIONS:

A. General:

1. Coordinate all work to conform to the progress of the work of other trades.
2. Complete the entire installation as soon as the condition of the building will permit. No extras will be allowed for corrections of ill-timed work, when such corrections are required for proper installation of other work.

B. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electrical systems within the cavity space allocation in the following order of priority:

1. Equipment and required clearances
2. Plumbing waste, cooling coil drain piping and roof drain mains and leaders.
3. Ductwork mains
4. Plumbing vent piping
5. Low pressure ductwork and air devices.
6. Electrical and communication conduits, raceways and cabletray.
7. Domestic hot and cold water
8. Fire sprinkler mains, branch piping and drops (locate as tight to structure as possible).
9. DDC control wiring and other low voltage systems.
10. Fire alarm systems.

C. Chases, Inserts and Openings:

1. Provide measurements, drawings and layouts so that openings, inserts and chases in new construction can be built in as construction progresses.
2. Check sizes and locations of openings provided. Including the access panels for equipment in hard lid ceilings and wall cavities.
3. Any cutting and patching made necessary by failure to provide measurements, drawings and layouts at the proper time shall be done at no additional cost in contract sum.

D. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other sections of the specifications can be built at the proper time.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Refer to Division 1 and Division 23.

G. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attentions to changes required in other work as result of modifications shall be paid for by responsible Contractor/Subcontractor.

H. Coordination with Electrical Work: Refer to Division 1 and 26.

1.6 DESIGN WORK REQUIRED BY CONTRACTOR:

A. The construction of this project requires the Contractor to include the detailing of several systems and/or subsystems. All such design work associated with the development of the system shall be the complete responsibility of the Contractor.

B. The Contractor shall take the full responsibility to develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers contract drawings shall be for system design intent and general configurations.

C. Systems or subsystems which require responsibility by the contractor include but are not limited to:

1. Final coordinated distribution of duct, plumbing and other systems within the ceiling cavity.
2. Any system not fully detailed
3. Fire protection systems
4. Equipment supports, hangers, anchors and seismic systems not fully detailed nor specified in these documents, or catalogued by the manufacturer.
5. Temperature controls systems
6. Refrigeration systems
7. Seismic restraint systems

D. Design Limitations:

1. The Contractor shall not modify the Engineers design intent in any way.
2. The Contractor shall not change any pipe size or equipment size without prior written approval from the Engineer.
3. The Contractor shall conform to the SMACNA Duct Construction Standards when modifying the ductwork layout to avoid collisions.
4. Back to back 90° fittings on duct system shall not be installed under any circumstance.
5. Bull nosed tees on duct systems shall not be installed under any circumstance.

1.7 PROJECT CONDITIONS:

A. Field verify all conditions prior to submitting bids.

B. Report any damaged equipment or systems to the Owner prior to any work.

C. Protect all mechanical and electrical work against theft, injury or damage from all causes until it has been tested and accepted.

D. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

1.8 REQUIREMENTS OF REGULATORY AGENCIES:

A. Refer to Division 1.

B. Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or

specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, SMACNA, EPA, OSHA and ASHRAE.

C. Comply with the most current adopted local and state codes adopted by the Authorities Having Jurisdictions at the time of permit application, including referenced standards, amendments and policies.

1. International Building Code
2. International Fire Code
3. Idaho State Plumbing Code
4. International Mechanical Code
5. International Fuel Gas Code
6. International Energy Conservation Code
7. NFPA 101 Life Safety Code

D. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

E. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

1.9 REQUIREMENTS OF LOCAL UTILITY COMPANIES:

A. Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required but not provided by Local Utility Company for the project.

B. Utility Connections:

1. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
2. The contract documents indicate the available information on existing utilities and services and on new services (if any) to be provided to the project by utility companies and agencies. Notify Engineer immediately if discrepancies are found.
3. Coordinate mechanical utility interruptions one week in advance with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

1.10 PERMITS AND FEES:

A. Refer to Division 1.

B. The Contractor shall pay all tap, development, meter, etc., fees required for connection to municipal and public utility facilities, unless directed otherwise by the General Contractor/Owner – IN WRITING.

C. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.

1.11 PROJECT SEISMIC REQUIREMENTS:

A. Installation shall comply with the local seismic requirements for the area of installation. Provide restraints, bracing, anchors, vibration isolation, seismic snubbers, and all other components required for the installation.

B. All systems shall be installed to meet NFPA and IBC Seismic requirements.

1. Where any conflicts arise the more stringent requirements shall be applicable.
2. The design of the seismic requirements shall be the full responsibility of the Contractor.

1.12 TEMPORARY FACILITIES:

A. Light, Heat, Power, Etc.: Responsibility for providing temporary electricity, heat and other facilities shall be as specified in Division 1.

B. Use of Permanent Building Equipment for Temporary Heating or Cooling: Permanent building equipment shall not be used without written permission from the Owner. If this equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. Steam and hydronic systems shall be flushed and chemically treated. Ductwork and air moving equipment shall be cleaned to an “AS New” condition. All filters required for the construction period shall be equivalent to the filters required for the final installation. All filters shall be replaced at the time of substantial completion. The guarantee period of all equipment used shall not start until the equipment is turned over to the Owner for his use. A written record of maintenance, operation and servicing shall be turned over to the owner prior to final acceptance.

1.13 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. Refer to the Instructions to Bidders and Division 1.

B. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.

C. Materials and equipment of equivalent quality may be submitted for substitution prior to bidding. This may be done by submitting to the Architect/Engineer at least ten (10) working days prior to the bid date requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.

1. Substitutions shall be allowed only upon the written approval of the Architect/Engineer NO EXCEPTIONS.
2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications or which does not have prior approval.

1.14 MECHANICAL SUBMITTALS:

A. General

1. Refer to the Conditions of the Contract (General and Supplementary), Division 1.
2. Contractor shall provide a submittal schedule appropriate for the size and schedule of the project. Limit the number of large submittals being reviewed at one time and coordinate timing of sections that are dependent on each other.
3. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.
4. The front of each submittal package shall be identified with the specification section number, job name, Owner's project number, date, Prime Contractor and Sub-Contractor's names, addresses, and contact information, etc. Each Specification Section shall be submitted individually and submittal shall be tabbed for the equipment/materials/etc. within the section. Submittals that are not complete with the required information will not be reviewed and will be sent back to be corrected.
5. Submittals shall be provided electronically. All electronic submittals need to be complete with all design information and stamped for conformity by the contractor. Submittals will be reviewed, marked appropriately and returned by the same means received.
6. An index shall be provided which includes:

    a. Product
    b. Plan Code (if applicable)
    c. Specification Section
    d. Manufacturer and Model Number

7. Submittal schedule shall be provided for review within four (4) working weeks from award of contract to successful bidder.

B. Basis of Design: The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the basis of design and provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.

C. All equipment shall conform to the State and/or local Energy Conservation Standards.

D. Contractor Review: Submittal of shop drawings, product data and samples will be accepted only when submitted by and stamped by the General Contractor. Each submittal shall be reviewed by the contractor for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Architect/Engineer. Any submittal not stamped or complete will be sent back. Data submitted from Subcontractors and material suppliers directly to the Engineer will not be processed unless prior written approval is obtained by the Contractor.

E. Submittal Review Process: Before starting work, prepare and submit to the Architect/Engineer shop drawings and descriptive equipment data required for the project. Continue to submit in the stated format after each Architect/Engineer's action until a "No Exception Taken" or "Make Correction Noted" action is received. When a "Make Corrections Noted" is received, make the required corrections for inclusion in the Operating and Maintenance Manual (O&M). Submittals marked "Make Corrections Noted" shall not be resubmitted during the submittal process. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned "Revise and Resubmit". Where an entire submittal package is returned for action by the Contractor, the Engineer may summarize comments in letter format and return the entire set. Submittals shall be prepared per the MECHANICAL SUBMITTAL CHECKLIST, at the end of this section; supplemental requirements are listed in each Division 21, 22, and 23 Sections.

F. The Design Professional's review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:

1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
2. Construction means or methods
3. Coordination of the work with other trades
4. Construction safety precautions

G. The Design Professional's review shall be conducted with reasonable promptness while allowing sufficient time in the Design Professional's judgment to permit adequate review. Review of a specific item shall not indicate that the Design Professional has reviewed the entire assembly of which the item is a component.

H. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.

I. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.

J. If more than two submittals (either for product data, shop drawings, record drawings, or test and balance reports) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

K. The contractor shall cloud all changes made on submittals that are marked "Revise and Resubmit."

L. Required Submittals: Provide submittals for each item of equipment specified or scheduled in the contract documents. See table at the end of this section.

1.15 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:

A. Product Listing:

1. Prepare listing of major mechanical equipment and materials for the project, within (2) two weeks of signing the Contract Documents and transmit to the Architect. A sample schedule is included at the end of this section to complete this requirement.

   a. Provide all information requested.
   b. Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION."

2. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.
3. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock,

welding rods, solder, fasteners, motors for dissimilar equipment units and similar items used in work, except as otherwise indicated.

a. Provide products which are compatible within systems and other connected items.

B. Schedule of Values

1. Provide preliminary schedule of values with product data submittal, within three (3) weeks from award of contract to successful bidder. Provide according to the following descriptions:

a. Site Utilities
b. Plumbing

1) Underground
2) Rough in
3) Fixtures
4) Trim
5) Insulation

c. Fire Protection
d. HVAC

1) Equipment
2) Sheet Metal
3) Piping
4) Insulation
5) Test and Balancing
6) Specialty Systems
7) Temperature Controls

e. Miscellaneous

2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.

C. Product Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
2. Delete or mark-out portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:

a. Sizes.
b. Weights.
c. Speeds.
d. Capacities.
e. Piping and electrical connection sizes and locations.
f. Statements of compliance with the required standards and regulations.
g. Performance data.
h. Manufacturer's specifications.

D. Shop Drawings:

1. Shop Drawings are defined as mechanical system layout drawings prepared specifically for this project, or fabrication and assembly type drawings of system components to show more detail than typical pre-printed materials.
2. Prepare Mechanical Shop Drawings, except diagrams, to accurate scale, min 1/8”-1'-0", unless otherwise noted.

    a. Show clearance dimensions at critical locations.
    b. Show dimensions of spaces required for operation and maintenance.
    c. Show interfaces with other work, including structural support.

E. Test Reports:

1. Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test.
2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.
3. Submit test reports as required for O & M manuals.

F. Operation and Maintenance Data: See separate paragraph of this specification section.

G. Software Licenses: Provide documentation of ownership under the owner’s corporate name (coordinate with owner’s representative for exact ownership wording) for Software Licenses provided as part of the work. Include information for updates, subscription requirements if applicable, backup, support, login, passwords, date when purchased, expiration date if applicable, version, etc. Include in the O & M Manual after review and "No Exceptions Taken" has been accomplished.

H. Record Drawings: See separate paragraph of this specification section.

1.16 DELIVERY, STORAGE, AND HANDLING:

A. Refer to Division 1 Sections on Transportation and Handling and Storage and Protection.

B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged and protected to prevent damage or contamination during shipment, storage, and handling.

C. Check delivered equipment against contract documents and submittals.

D. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust, freezing, heat and moisture.

E. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

F. Protect stored ductwork, pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

G. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or be packaging with durable, waterproof wrapping.

H. Protect sheet metal ductwork and fittings. Elevate and store above grade and cover ends with waterproof wrapping.

1.17 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.

C. Work through all coordination before rough-in begins.

1.18 ACCESSIBILITY:

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

C. Furnish hinged steel access doors with concealed keylock latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification and Division 23 for duct access door requirements.

D. The minimum size of any access door shall not be less than the size of the equipment to be removed or 12 inches x 12 inches if used for service only.

E. Furnish doors to trades performing work in which they are to be built, in ample time for building-in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.

F. Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed. In lieu of these doors, approved shop fabricated access doors with DuroDyne hinges may be used.

G. Access doors in fire-rated walls and ceilings shall have equivalent U.L. label and fire rating.

H. Final installed conditions shall accommodate accessibility and replacement of system components that regularly require service and replacement. This includes control devices, sensors, motors, etc.. Such devices shall not be permanently obstructed by building systems such as piping, ductwork, insulation, drywall, etc.

1.19 BELTS, SHEAVES, IMPELLERS:

A. The Mechanical Contractor shall coordinate with the Test and Balance Contractor and supply correctly-sized drive belts, sheaves, and trimmed impellers.

1.20 EXCAVATING AND BACKFILLING:

A. General:

1. Provide all necessary excavation and backfill for installation of mechanical work in accordance with Division 2.
2. In general, follow all regulations of OSHA as specified in Part 1926, Subpart P, "Excavations, Trenching and Shoring." Follow specifications of Division 23 as they refer specifically to the mechanical work.

B. Contact Owners of all underground utilities to have them located and marked, at least 2 business days before excavation is to begin. Also, prior to starting excavation brief employees on marking and color codes and train employees on excavation and safety procedures for natural gas lines. When excavation approaches gas lines, expose lines by carefully probing and hand digging.

C. Pipe Trenching:

1. Provide all necessary pumping, cribbing and shoring.
2. Walls of all trenches shall be a minimum of 6 inches clearance from the side of the nearest mechanical work. Install pipes with a minimum of 6 inches clearance between them when located in same trench.
3. Dig trenches to depth, width, configuration, and grade appropriate to the piping being installed. Dig trenches to 6inches below the level of the bottom of the pipe to be installed. Install 6 inches bed of pea gravel or squeegee, mechanically tamp to provide a firm bed for piping, true to line and grade without irregularity. Provide depressions only at hubs, couplings, flanges, or other normal pipe protrusions.

D. Backfilling shall not be started until all work has been inspected, tested and accepted. All backfill material shall be reviewed by the soils engineer. In no case shall lumber, metal or other debris be buried in with backfill.

1. Provide warning tape for marking and locating underground utilities. Tape shall be specifically manufactured for this purpose and shall be polyethylene film, 6 inches wide, 0.004 inches thick and have a minimum strength of 1750 psi. Tape shall carry continuous inscription naming the specific utility.

    a. Tape shall have magnetic strip and be used for exterior underground system only.

E. Trench Backfill:

1. Backfill to 12 inches above top of piping with pea gravel or squeegee, the same as used for piping bed, compact properly.
2. Continue backfill to finish grade, using friable material free of rock and other debris. Install in 6 inch layers, each properly moistened and mechanically compacted prior to installation of ensuing layer. Compaction by hydraulic jetting is not permissible.

F. After backfilling and compacting, any settling shall be refilled, tamped, and refinished at this contractor's expense.

G. This contractor shall repair and pay for any damage to finished surfaces.

H. Complete the backfilling near manholes using pea gravel or squeegee, installing it in 6 inch lifts and mechanically tamping to achieve 95 percent compaction.

I. Use suitable excavated material to complete the backfill, installed in 6 inch lifts and mechanically compacted to seal against water infiltration. Compact to 95 percent for the upper, 30 inches below paving and slabs and 90 percent elsewhere.

1.21 NAMEPLATE DATA:

A. Provide permanent operational data nameplate on each item of mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Coordinate with Owner for specific requirements.

1.22 LUBRICATION OF EQUIPMENT:

A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

B. Contractor shall properly lubricate all mechanical pieces of equipment which he provided before turning the building over to the Owner. He shall attach a linen tag or heavy duty shipping tag on the piece of equipment showing the date of lubrication and the type and brand of lubricant used.

1.23 CLEANING:

A. Refer to Division 1.

1.24 RECORD DOCUMENTS:

A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

B. Keep a complete set of record document prints in custody during entire period of construction at the construction site. Documents shall be updated on a weekly basis.

C. Mark Drawing Prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping or ductwork relocated more than 1foot-0inches from where shown on the drawings.

D. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Mark equipment and fixture schedules on drawings to indicate manufacturer and model numbers of installed equipment and fixtures.

F. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme:

1. Red shall indicate new items, deviations and routing.
2. Green shall indicate items removed or deleted.
3. Blue shall be used for relevant notes and descriptions.

G. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up .pdf format readable by Bluebeam is preferred.

1.25 OPERATION AND MAINTENANCE DATA:

A. Refer to Division 1.

B. No later than four (4) weeks prior to the completion of the project provide one complete set of Operating and Maintenance Manuals, or as specified in Sections of Division 1 (whichever is more stringent).

C. The testing and balancing report shall be submitted and received by the Engineer at least fifteen calendar days prior to the contractor's request for final observation time frame requirements. Include in the O & M Manual after review with "No Exceptions Taken" has been accomplished.

D. In addition to the information required by Division 1 for Maintenance Data, include the following information:

1. The job name and address and contractor's name and address shall be identified at the front of the electronic submittal.
2. Description of mechanical equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
3. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions. Provide any test reports and start-up documents.
4. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
5. Servicing instructions, lubrication charts and schedules, including Contractor lubrication reports.
6. Manufacturer's service manuals for all mechanical equipment provided under this contract.
7. Include the valve tag list.
8. Name, Address and Telephone numbers of the Sub-contractors and local company and party to be contacted for 24-hour service and maintenance for each item of equipment.
9. Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.
10. Complete recommended spare parts list.
11. Mechanical System and Equipment Warranties.
12. Copies of all test reports shall be included in the manuals.
13. Provide manuals with dividers for major sections and special equipment. Mark the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
14. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up PDF format readable by Bluebeam is preferred.

1.26 PROJECT CLOSEOUT LIST:

A. In addition to the requirements specified in Division 1, complete the requirements listed below.

B. The Contractor shall be responsible for the following Mechanical Submittal Checklist either by performing and/or coordinating such items prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements. (Checklist is located at the end of this section.)

1.27 WARRANTIES:

A. Refer to the Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case the entire mechanical system shall be warranted no less than one year from the time of acceptance by the Owner.

B. Compile and assemble the warranties specified in Division 21, 22, and 23, include the Operating and Maintenance Manuals.

C. Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.28 CONSTRUCTION REQUIREMENTS:

A. The contractor shall maintain and have available at the jobsite current information on the following at all times:

1. Up to date record drawings.
2. Submittals
3. Site observation reports with current status of all action items.
4. Test results; including recorded values, procedures, and other findings.
5. Outage information.

1.29 MECHANICAL SUBMITTAL CHECKLIST:

Spec Section	Item	Requirements							
		Submittals			Supplemental		Factory Rep Super-Vision At Site	Training Req'd At Site	Extra Material
		Shop Drawings	Product Data	Include In O & M	Test[3]	Report[3]			
210500	Common Work Results For Fire Suppression	X	X	X	X	X		X	X
211119	Fire Department Connections		X	X					
211313	Wet Pipe Sprinkler Systems	X	X	X	X	X		X	X
211316	Dry Pipe Sprinkler Systems	X	X	X	X	X		X	X
220500	Common Work Results For Plumbing			X					
220523	General Duty Valves for Plumbing Piping		X	X					
220529	Hangers & Supports for Plumbing Piping & Equipment		X	X		X			

Spec Section	Item	Requirements							
		Submittals			Supplemental		Factory Rep Super-Vision At Site	Training Req'd At Site	Extra Material
		Shop Drawings	Product Data	Include In O & M	Test[3]	Report[3]			
220553	Identification for Plumbing Piping		X						
220700	Plumbing Insulation		X	X					
221116	Domestic Water Piping		X	X	X	X			X
221119	Domestic Water Piping Specialties		X	X	X	X			x
211123	Domestic Water Pumps		X	X					x
221316	Sanitary Waste Piping		X	X					
221319	Sanitary Waste Piping Specialties		X	X					
221413	Facility Storm Drainage Piping		X	X					
221423	Storm Drainage Piping Specialties		X	X					
224000	Plumbing Fixtures		X	X					
230500	Preliminary Schedule Of Values					X			
230500	Final Schedule Of Values			X		X			
230500	Equipment Warranties			X					
230500	O&M Manuals		X	X		X			X
230500	Record Drawings	X	X	X					
230529	Hangers and Supports		X	X					
230548	Vibration and Seismic Control	X	X	X	X	X			
230553	Identification for HVAC		X						
230593	Testing ,Adjusting and Balancing	X		X	X	X			
230700	HVAC Insulation		X	X					
230900	Instrumentation and Control for Mechanical	X	X	X		X	X	X	
231123	Facility Natural Gas Piping	X	X	X	X	X			
233113	Metal Ducts	X	X	X	X	X			
233300	Air Duct Accessories		X	X					X
233423	Power Ventilators		X	X				X	X
233713	Diffusers, Registers & Grilles		X	X					X
235123	Gas Vents		X	X					

Spec Section	Item	Requirements							
		Submittals			Supplemental		Factory Rep Super-Vision At Site	Training Req'd At Site	Extra Material
		Shop Drawings	Product Data	Include In O & M	Test[3]	Report[3]			
235523.13	Low Intensity Gas Fired Radiant Heaters		X	X					
237223	Air to Air Energy Recovery Equipment		X	X					
238126	Ductless Split Systems		X	X					
238216.14	Coils		X	X				X	
238239.19	Wall and Ceiling Units		X	X					

Notes:
[1] For Starters and Variable Frequency Drives
[2] Requires Review & Approval of calibrated balance valves from T & B Contractor
[3] See Specific Specification Section for Test & Certification Requirements

[1] For Starters and Variable Frequency Drives
[2] Requires Review & Approval of calibrated balance valves from T & B Contractor
[3] See Specific Specification Section for Test & Certification Requirements

END OF SECTION 230500

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fastener systems.
4. Pipe stands.
5. Equipment supports.

B. Related Sections:

1. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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

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

1.5 ACTION SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Nonmetallic Coatings: Plastic coating, jacket, or liner.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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. Allied Tube & Conduit.
b. Cooper B-Line, Inc.
c. Flex-Strut Inc.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut Corporation; Tyco International, Ltd.
g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.
8. Paint Coating: Vinyl.

2.4 FASTENER SYSTEMS

A. Mechanical Fasteners: Screw in-type, anchors, for use in wood framing; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: Plastic unit with threaded-rod supported roller, pipe clamps to secure pipe, for roof installation without membrane penetration. MIRO-3-RAH-7 or equal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

D. Fastener System Installation:

1. Install fasteners for use in wood. Verify with joist manufacture method and placement of fasteners.

E. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

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

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments attach to structure. Install additional attachments at concentrated loads.

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

K. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

3.2 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.3 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.4 PAINTING

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

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

3.5 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
3. Adjustable Band Hangers (MSS Type 9): For suspension of insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
4. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (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.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system 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 (680 kg).

2. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

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

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

END OF SECTION 230529

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Duct labels.
3. Stencils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

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. Brady Corporation.
b. Brimar Industries, Inc.
c. Carlton Industries, LP.
d. Champion America.
e. Craftmark Pipe Markers.
f. emedco.
g. Kolbi Pipe Marker Co.
h. LEM Products Inc.
i. Marking Services, Inc.
j. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Blue.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
7. Minimum Letter Size: 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-quarters the size of principal lettering.
8. Fasteners: Stainless-steel [**rivets**] [**or**] [**self-tapping screws**].
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 STENCILS

A. Stencils for Ducts:

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. Brimar Industries, Inc.
    b. Carlton Industries, LP.
    c. Champion America.
    d. Craftmark Pipe Markers.
    e. Kolbi Pipe Marker Co.
    f. Marking Sevices Inc.

2. Lettering Size: Minimum letter height of 1-1/4 inches (32 mm) for viewing distances up to 15 feet (4-1/2 m) and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Fiberboard or metal.
4. Identification Paint: Interior, alkyd enamel or acrylic enamel. Paint may be in pressurized spray-can form.

B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

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. Brimar Industries, Inc.
    b. Carlton Industries, LP.
    c. Champion America.
    d. Craftmark Pipe Markers.
    e. Kolbi Pipe Marker Co.
    f. Marking Sevices Inc.

2. Lettering Size: Minimum letter height of 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

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

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

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

3.3 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.4 DUCT LABEL INSTALLATION

A. Stenciled Duct Label: Stenciled labels showing service and flow direction to be provided.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 230553

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

2. Balancing Water Systems

a. Domestic hot water recirc.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. Certified TAB reports.

B. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following:

1. Felts House
2. NWESI
3. BST
4. Blue Sky

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine the approved submittals for HVAC systems and equipment.

C. 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.

D. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

E. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

F. Examine test reports specified in individual system and equipment Sections.

G. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

H. 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.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Automatic temperature-control systems are operational.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

C. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Adjust fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

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. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure 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 air 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 air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch 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.

3.7 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.8 TOLERANCES

A. Set HVAC system's air flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: 0 to Plus or Minus 5 percent.
2. Air Outlets and Inlets: 0 to Plus or Minus 5 percent

3.9 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.

D. Evap Coolers, RTUs, Fan Coils and Energy Recovery Units Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.

c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

3. Test Data (Indicated and Actual Values):

a. Total air flow 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. Outdoor airflow in cfm (L/s).
f. Return/exhaust airflow in cfm (L/s).
g. Outdoor-air damper position.

E. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary air flow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).3

F. Split System AC Units and Radiant Heat

1. Unit data
2. Test data

a. Verify operation of units, controls, etc.

3.10 DOMESTIC HOT WATER

A. Balance domestic hot water recirc pump and piping.

3.11 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Mineral fiber.

2. Factory-applied jackets.
3. Tapes.
4. Securements.

B. Related Sections:

1. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per 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 and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; All-Service Duct Wrap.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.4 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.5 SECUREMENTS

A. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; Cupped Head Weld Pin.
        3) Midwest Fasteners, Inc.; Cupped Head.
        4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
        2) GEMCO; Perforated Base.
        3) Midwest Fasteners, Inc.; Spindle.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    c. Spindle: Copper- or zinc-coated, low carbon steel, Aluminum or Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; RC-150.
        2) GEMCO; R-150.
        3) Midwest Fasteners, Inc.; WA-150.
        4) Nelson Stud Welding; Speed Clips.

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

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.

1. Verify that systems and equipment 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.

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 equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and 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. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- (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 4 inches (100 mm) o.c.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. 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 Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 MINERAL-FIBER INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    b. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    c. Do not overcompress insulation during installation.
    d. Impale insulation over pins and attach speed washers.

e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, vapor barrier consisting of factory- or field-applied jacket, adhesive, and seal at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.6 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, exposed and concealed supply, return, exhaust to energy recovery and outdoor air.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.7 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, concealed, rectangular and round, return, exhaust to energy recovery, outdoor and supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: R-6 minimum.
2. Where insulation passes outside building insulation envelope R-8 minimum.

3.8 VRF PIPING

A. Insulate with flexible unicellular insulation per manufacturer requirements

END OF SECTION 230700

SECTION 23 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Grout.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves.

3. Pressure regulators.

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. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

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:

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
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. 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.

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. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

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. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.

7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

C. Bronze Plug Valves: MSS SP-78.

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. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.
    f. Maxitrol Company.
    g. Richards Industries; Jordan Valve Div.

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: as required.

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

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. Canadian Meter Company Inc.
    b. Eaton Corporation; Controls Div.
    c. Harper Wyman Co.
    d. Maxitrol Company.
    e. SCP, Inc.

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. Maximum Inlet Pressure: as required.
9. Atmospheric vent with pipe connection for venting outside if installed indoors.

2.6 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

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

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

2.7 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 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 the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

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

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

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

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

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

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

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

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    c. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
    d. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw or spring clips.
    e. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. 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.

O. Extend relief vent connections for line and appliance regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. 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.

Q. 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 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.

3. Prohibited Locations:

a. Do not install natural-gas piping in or through circulating air ducts, ventilating ducts.
b. Do not install natural-gas piping in solid walls or partitions.

R. Use reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

S. Connect branch piping from top or side of horizontal piping.

T. 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.

U. Do not use natural-gas piping as grounding electrode.

3.5 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.

3.6 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.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes, per MSS SP-69:

1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm).
2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm).
3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m).
4. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m).

3.8 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.

3.9 PAINTING

A. Paint exposed, exterior metal piping, valves, service regulators, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    c. Topcoat: Exterior alkyd enamel flat.
    d. Color: Gray.

B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints. 2” and smaller.
2. Steel pipe with wrought-steel fittings and welded joints. 2-1/2” and larger.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints, 2” and smaller.
2. Steel pipe with wrought-steel fittings and welded joints. 2 ½” and larger.

3.13 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. Two-piece, full-port, bronze ball valves 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. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

C. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

E. Valves in branch piping for single appliance shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

END OF SECTION 231123

SECTION 23 25 00 – WATER TREATMENT FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of water treatment system work required by this section is indicated on drawings and schedules and by requirements of this section, and includes necessary equipment, chemicals, and service for the following systems:

1. Water Conditioners

B. Provide chemicals and service program for a period of one year from start-up date of equipment, including the following:

1. Initial water analysis and recommendations.
2. Systems start-up assistance.
3. Training of operating personnel.
4. Periodic field service and consultation.
5. Customer report charts and log sheets.
6. Laboratory technical assistance.

1.2 QUALITY ASSURANCE:

A. Manufacturer's and Representative Qualifications. Firms regularly engaged in manufacture of water treatment equipment, chemical and service shall have been active in the field of industrial water treatment and whose products have been in satisfactory use in similar service for not less than 5 years, and shall have full-time service personnel located within the trading area of job site.

B. Codes and Standards:

1. ASME Compliance: Construct softener tanks in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, provide stamp and certification.
2. UL Labels: Provide water conditioners ancillary electrical components, which have been listed and labeled by UL.
3. NEMA Standards: Provide electrical controls and enclosures conforming to applicable standards of NEMA for environment where water conditioners are indicated.
4. NSE Compliance: Construct and install water conditioners in accordance with NSF Standard 44 "Cation Exchange Water Softeners Relating to Supplementary Treatment of Potable Water."
5. Chemical Standards: Provide only chemical products, which are acceptable under state and local public health and pollution control regulations.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product including rated capacities of selected equipment clearly indicating water pressure drops, weights, installation and start-up instructions, and furnished specialties and accessories.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to water treatment equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Divisions 1 and 23.

E. Maintenance Data: Submit maintenance data and parts list for each item of equipment, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 23.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Handle water treatment materials and components carefully to prevent damage, breaking, denting and scoring to materials and equipment. Deliver packaged units in original crates. Do not install damaged water treatment materials and components; remove from site and replace with new.

B. Store water treatment materials and components in an environment satisfactory to prevent their damage by the elements.

1.5 EXTENDED MAINTENANCE SERVICES:

A. Agreement to Maintain: Prior to time of final acceptance, submit four copies of "Agreement for continued Service and Maintenance" for water treatment system, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.

PART 2 - PRODUCTS

2.1 SUPPLIERS:

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

1. Water Conditioners and Filtering Equipment:

a. Columbia Water Conditioning Co.
b. Permuitt
c. Culligan
d. US Filter

2.2 WATER CONDITIONERS:

A. Commercial Water Softener (Steel Tanks):

1. Provide a single vertical tank as specified below with a 80 inch side shell and 30 inch barrel. The tank shall be of the vertical down flow pressure type with automatic controls to operate on the sodium cycle. The influent water has a hardness of 18 grains per gallon. The system shall be capable of delivering soft water at 152 gpm continuously with a pressure drop not to exceed 15 psig. The influent and effluent face piping and valves shall be 3 inches in size. The mineral tanks shall be constructed of carbon steel,

having an operating pressure of 125 psig and hydrostatic tested at a pressure of 50 percent in excess of the operating pressure.

a. ASME Compliance: Construct softener tanks in accordance with ASME Boiler and Pressure Vessel Code, Section VIII. Provide stamp and certification.
b. NSF Compliance: Construct and install water conditioners in accordance with NSF Standard 44 "Cation Exchange Water Softeners Relating to Supplementary Treatment of Potable Water."
c. Mineral Standard: Provide mineral products acceptable under state and local public health control regulations.
d. Tanks 24 inch Diameter and Larger: Provide an 11 inch x 15 inch manhole, in the top head. The tank side shall be double butt welded with no un-welded or open seams on the interior of the tank. The tank shall also be provided with two lifting lugs to facilitate the handling and positioning of the equipment.
e. Support Legs: Construct legs of structural steel angle with foot pads. The legs shall be designed to properly support the softener tank under dynamic loading. Stirrup legs will be unacceptable.
f. Finish: The tank shall be internally sand blasted and lined with a phenolic epoxy, applied eight to ten mils thick. The tank shall be externally painted with a rest inhibiting primer 2-3 mils dry film thickness with an enamel overcoat.
g. Freeboard: Provide minimum freeboard of 50 percent of the mineral bed depth to allow for adequate resin expansion during backwash.

2. Upper Distribution: The tank shall be equipped with a "Schedule 80 PVC upper distributor sized to match the face piping of the softener. The distributor design shall be a 4-point splash dome system, capable of distributing the water evenly over the resin bed.
3. Lower Distribution: The tank shall be equipped with a "Schedule 80 PVC header/lateral lower distributor sized to match the face piping of the softener. The equally spaced laterals shall have slot openings of 0.01inch. The distribution system shall be imbedded in a 9 inch layer of washed ¼" x 1/8 inch gravel to support the resin bed, with a 3 inch layer of coarse silica sand on top. The mechanical Contractor shall be responsible for installing the support gravel and sand under the supervision of the Water Softener Manufacturer.
4. Controls: The system controls shall have adjustable duration of the various steps in regeneration and shall allow for push button start, as well as complete manual override operations. Softener regeneration shall be initiated by:

   a. One of two electronic register head water meters that will produce an electrical signal to indicate, need for regeneration upon reaching hand set gallonage. Design so signal will continue until automatically reset. Meter shall be capable of indicating rate of flow and total flow.
   b. An electric time clock which will initiate regeneration at any hour of day and any day of the week.

5. Main operating Valve: Provide industrial automatic multi-port diaphragm type, slow opening and closing control valve free of water hammer. The valve shall be diaphragm powered and hydraulically operated with a position indicator to indicate position of main operating valve. Dissimilar metals shall be isolated within the valve. Provide a valve that requires no special tools for service. Equip valve with internal automatic self-adjusting brine injector to draw brine and rinse at constant rate independent of pressure. Provide single units with internal automatic by-pass of untreated water during regeneration.
6. Five independent Aqua-Matic Series 420 diaphragm valves for regeneration, shall be provided. Diaphragm valves are to be constructed of cast iron with a 125 psig rating.

The valves shall be hydraulically powered, having an upper and lower chamber for power opening and closing, and shall not utilize springs in their operation.

7. Mineral Standards: Provide mineral products acceptable under state and local public health control regulations.

    a. The softener shall be provide with 10 cubic feet of Purolite C-100 cation exchange resin, having a minimum exchange capacity of 30,000 grains when regenerated with 15 lbs. of salt per cubic foot. The media shall be of proper particle size (not more than 4percent through 40 mesh U.S. standard screens, wet screening), and will contain no agglomerates, shells, plates, or other shapes which might interfere with the normal function of the water softeners. The media shall be installed in the field by the mechanical contractor, under the supervision of the softener manufacturer.

8. Brine System: Provide a single brine measuring and dry salt storage tank with salt platform sufficiently sized for at least 4 regenerations at full salting. Construct tank of 3/16 inch thick fiberglass or 3/8 inch thick molded polyethylene with cover. Equip brine tank with float-operated plastic fitted brine valve for automatic control of brine withdrawn and fresh water refill.
9. Accessories: Provide the following:

    a. Pressure gauges for hard water inlet and soft water outlet.
    b. Sampling cocks for hard water inlet and soft water outlet for each tank.
    c. Provide complete water testing set for hardness.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Coordination where installation of Water Treatment equipment in piping systems is required with the other work (plumbing and heating piping) as necessary to interface components of water treatment equipment. Provide installation instructions to those firms providing installation.

B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
2. Install pressure gauges, valves, and controls furnished by manufacturer, in accordance with manufacturer's instructions.

3.2 INSTALLATION OF WATER CONDITIONERS:

A. General: Install water conditioners where indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that water conditioners comply with requirements and service for the intended purposes.

B. Access: Provide access and service space around and over water conditioners as indicated, but in no case less than that recommended by manufacturer.

C. Support: Provide 4inch high concrete pad under water conditioners. Plumb and level units.

D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

E. Piping Connections: Provide shutoff valves and unions or flanges on water connections. Pipe drain to nearest floor drain of suitable size for the backwash of the softener.

3.3 INSPECTION:

A. Examine areas and conditions under which water treatment systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.4 FIELD QUALITY CONTROL:

A. Sample water softener effluent at one-week intervals after start-up for period of 3 weeks and prepare test report on the conditions of the water.

3.5 SYSTEM START-UP:

A. The Water Treatment Supplier shall put the system into operation, and make adjustments necessary for proper operation.

B. The Water Treatment Supplier shall provide a written report to the Division 23 Contractor indicating that the start-up has been completed and that all Water Treatment Equipment is operating properly.

3.6 TESTING AND CLEANING:

A. Sample all treated water systems at one-week intervals after start-up for period of 4 weeks and prepare certified test report for each system being treated.

B. Start-up test, and adjust water conditioners in presence of manufacturer's authorized representative. Operate units including regeneration, back washing, rinsing and flushing. Adjust unit to maintain required steady state effluent water quality.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.7 EXTRA STOCK:

A. In addition to startup salt, furnish ten 80-lb bags of salt on a pallet and store where requested by Owner. Obtain a receipt from Owner for this salt.

3.8 CLOSEOUT PROCEDURES:

A. Provide services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of water treatment systems.

1. Schedule training with Owner, provide at least 7 day notice to Contractor and Engineer of training date.

END OF SECTION 23 25 00

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible". SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

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. Lindab Inc.
    b. McGill AirFlow LLC.
    c. SEMCO Incorporated.
    d. Sheet Metal Connectors, Inc.
    e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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. CertainTeed Corporation; Insulation Group.
    b. Johns Manville.
    c. Knauf Insulation.

d. Owens Corning.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel, aluminum or stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

a. Fan discharges.
b. Intervals of lined duct preceding unlined duct.

9. Terminate inner ducts with buildouts attached to dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.6 HANGERS AND SUPPORTS

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

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

2.7 SEISMIC-RESTRAINT DEVICES

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.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized or ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

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. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines." Deliver, store and after install all duct with sealed plastic on ends.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

D. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Structural fasteners appropriate for construction materials to which hangers are being attached.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
2. Brace a change of direction longer than 12 feet (3.7 m).

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service or an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 TESTING

A. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

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

C. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Maintain plastic seal over open ends during shipping, storage and after install to keep interior clean.

3.9 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel.

B. Supply Ducts:

1. Ducts Connected to, Fan Coils, ERVs, Evap Coolers and Terminal Units:

    a. Pressure Class: Positive 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6

2. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive 2-inch wg (500 Pa.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Return Ducts:

1. Ducts Connected to Fan Coils, ERVs, Evap Coolers and Terminal Units:

    a. Pressure Class: Positive or negative 1-inch wg (250 Pa).
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air and ERV’s:

    a. Pressure Class: Negative 1-inch wg (250 Pa).
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

E. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, 1-1/2 inches (38 mm) thick.
2. Return Air Ducts: Fibrous glass, Type I, 1-1/2 inches (38 mm) thick.
3. Supply Fan Plenums: Fibrous glass, Type II, 1-1/2 inches (38 mm) thick.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm (5 m/s) or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 with vanes.

b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.

2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or multi-piece with joints sealed.
c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees."

a. Velocity 1000 fpm (5 m/s) or Lower: Conical tap.
b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

H. Duct Sealing:

1. Seal transverse and longitudinal joints with water-based duct sealant

END OF SECTION 233113

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Combination Fire/Smoke dampers
3. Flange connectors.
4. Turning vanes.
5. Remote damper operators.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

1.3 QUALITY ASSURANCE

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 AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 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: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Exposed-Surface Finish: Mill phosphatized.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. Flexmaster U.S.A., Inc.
    d. McGill AirFlow LLC.
    e. METALAIRE, Inc.
    f. Nailor Industries Inc.
    g. Pottorff; a division of PCI Industries, Inc.
    h. Ruskin Company.
    i. Trox USA Inc.
    j. Vent Products Company, Inc.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Hat-shaped, galvanized-steel channels, 0.064-inch (1.62-mm) minimum thickness.
    b. Mitered corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch (1.62 mm) thick.

6. Blade Axles: Nonferrous metal.
7. Bearings:

    a. Oil-impregnated bronze or Molded synthetic.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Aluminum, Manual Volume Dampers:

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. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. Flexmaster U.S.A., Inc.
    d. McGill AirFlow LLC.
    e. METALAIRE, Inc.
    f. Nailor Industries Inc.
    g. Pottorff; a division of PCI Industries, Inc.

h. Ruskin Company.
i. Trox USA Inc.
j. Vent Products Company, Inc.

2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat], U or Angle-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
d. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

6. Blade Axles: Nonferrous metal.
7. Bearings:

a. Oil-impregnated bronze, Molded synthetic or Stainless-steel sleeve.

8. Blade Seals: Felt.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Aluminum.
11. Accessories:

a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Damper Hardware:

1. 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.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

D. Branch Duct Spin-Ins with Hand Dampers:

1. Shop built damper with scoop, single blade with end bearing support, locking lever handle blade sized for 98% close off. Provide solid shaft blade support on 8” and larger

2.3 COMBINATION FIRE AND SMOKE DAMPERS

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. Aire Technologies.
2. American Warming and Ventilating; a Mestek Architectural Group company.
3. Cesco Products; a division of MESTEK, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. Pottorff.
7. Ruskin Company.

8. Safe Air - Dowco Products.
9. United Enertech.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Fire Rating: 1-1/2 and 3 hours.

D. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with welded interlocking, gusseted or mechanically attached corners and mounting flange.

E. Heat-Responsive Device: Resettable, 165 deg F (74 deg C) rated, fire-closure device.

F. Blades: Roll-formed, horizontal, interlocking, overlapping, 0.063-inch- (1.6-mm-) or 0.034-inch- (0.85-mm-) thick, galvanized sheet steel.

G. Leakage: Class I.

H. Rated pressure and velocity to exceed design airflow conditions.

I. Mounting Sleeve: Factory-installed, 0.039-inch- (1.0-mm-) or 0.05-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking if required by UL Label.

J. Damper Motors: two-position action.

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

1. Motor Sizes: Minimum size as required. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
3. Electrical Connection: 115 V, single phase, 60 Hz. Power open spring closed. Verify with fire alarm system requirements.

L. Accessories:

1. Test and reset switches, damper mounted.

2.4 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.5 TURNING VANES

A. 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. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

2.6 REMOTE DAMPER OPERATORS

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. Pottorff; a division of PCI Industries, Inc.
2. Ventfabrics, Inc.
3. Young Regulator Company.

B. Description: Gear and shaft system designed for remote manual damper adjustment.

C. Shaft: Steel.

D. Recessed-Box: Recessed, depth to accommodate ceiling construction.

E. Box Cover-Plate Material: Painted Steel.

2.7 DUCT-MOUNTED ACCESS DOORS

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. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Flexmaster U.S.A., Inc.
5. Greenheck Fan Corporation.

6. McGill AirFlow LLC.
7. Nailor Industries Inc.
8. Pottorff; a division of PCI Industries, Inc.
9. Ventfabrics, Inc.
10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

   a. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.

2.8 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 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. Provide metal compatible with connected ducts.

E. 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).

2.9 FLEXIBLE DUCTS

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. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 6-inch wg positive and 1.0-inch wg (250 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20 m/s).
3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.
2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.10 DUCT ACCESSORY HARDWARE

A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install backdraft dampers at outlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On downstream sides of elbows with turning vanes for cleaning.

F. Install access doors with swing against duct static pressure.

G. Install flexible connectors to connect ducts to equipment.

H. Connect diffusers to ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

I. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.
4. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 23 34 23 - POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Ceiling mounted ventilators.
2. Centrifugal roof exhaust
3. Residential range hood
4. Industrial propeller
5. Diesel Vehicle Exhaust Removal System

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and 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.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

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

C. Field quality-control test reports.

D. 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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTING VENTILATORS

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. Breidert Air Products.
2. Broan Mfg. Co., Inc.
3. Carnes Company HVAC.
4. Greenheck.
5. Loren Cook Company.
6. Penn Ventilation.

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Plastic, Stainless steel or Aluminum, louvered grille with flange or for inline bottom access panel on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Isolation: Rubber-in-shear vibration isolators.
2. Manufacturer's standard roof jack or wall cap, and transition fittings.
3. Access panel bottom for inline ceiling mounted access if required.

H. Capacities and Characteristics: As scheduled.

2.2 MOTORS

A. Enclosure Type: Totally enclosed, fan cooled.

2.3 CENTRIFUGAL ROOF VENTILATORS

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. Breidert Air Products.
2. Broan Mfg. Co., Inc.
3. Carnes Company
4. Greenheck Fan Corporation
5. Loren Cook Co
6. PennBarry

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun aluminum discharge baffle to direct discharge air upward, with rain and snow drains
2. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance

C. Fan Wheels: Aluminum hub and wheel with backward inclined blades

D. Belt Drives:

1. Resiliently mounted to housing
2. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable pitch motor pulley
5. Fan and motor isolated from exhaust airstream

E. Accessories

1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside or outside fan housing, factory wired through an internal aluminum conduit.

2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire
3. Dampers: Counterbalanced, parallel blade, backdraft dampers mounted in curb base; factory set to close when fan stops

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2 inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2 inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without cant strip, with mounting flange
2. Overall Height: 16 inches
3. Sound Curb: Curb with sound absorbing insulation
4. Pitch Mounting: Manufacture curb for roof slop if required.

G. Capacities and Characteristics: As scheduled on drawings

2.4 RESIDENTIAL RANGE HOOD

A. Acceptable 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. Nutone
2. Broan
3. Breidet

B. Unit to be built of brush stainless with fully enclosed bottom and dishwasher safe filter, convertible outlet rectangular to round, ducted, with centrifugal blower and halogen lamps. Blower and lamps to be controlled via four level electronic control. Unit to be UL Labeled.

2.5 INDUSTRIAL PROPELLOR

A. Low speed pedestal mount, ceiling circulation fan with airfoil blades, gearless direct drive motor, hanging tube and wired wall speed controller switch. Verify pedestal length and order accordingly. Similar to Big Ass Fan as scheduled.

2.6 MOTORS

A. Enclosure Type: Totally enclosed, fan cooled.

2.7 DIESEL VEHICLE EXHAUST REMOVAL SYSTEM

A. Sliding suction rail and Flex-Hose track systems

B. Extraction System Overview

1. The exhaust system shall be designed to vent 100% of exhaust gases and particulate safely to the outside of the fire station. The exhaust system shall b designed and installed by factory authorized personnel, which have been certified by the manufacturer of the exhaust system. Manufacturers shall be required to have a minimum of five years of proven experience in the manufacturing of emergency vehicle exhaust extraction equipment with a minimum of 250 installations. This experience must include a vehicle

(or) vehicles that have made 1200 emergency response calls a year for a minimum of 3 years. The purpose of this section of the specification ensures that the vendor has a proven system for durability in high-run departments.

2. This specified requirement allows the fire department to use the exhaust system for checking the vehicle pump and engine when it is inconvenient to do so outside the station house and without creating unnecessary performance criteria
3. System Description: The exhaust system shall be a source-capture system designed to handle ten vehicles. Seven of the vehicles are located in the main building and will require a suction rail system, while three of the vehicles are located in the auxiliary building and will utilize the flex-hose track system

C. Airflow Requirements

1. Exhaust system shall be designed to eliminate vehicle exhaust gases by creating a negative pressure vacuum from vehicle tailpipe to the inlet of the fan. The exhaust fan shall provide a minimum of 600 cfm at 6.0 inches static pressure loss to allow for any future expansion. Motor/ Blower curve information from the manufacturer must be provided with the bid document showing air handling capacity at various static pressure losses.
2. This exhaust system shall extract hot exhaust gases by creating a vacuum around entire exhaust tailpipe to draw the exhaust gases and particulate into the connection nozzle and induce cooler, ambient air at the universal nozzle and tailpipe adapter connection.
3. The system shall be designed to vent toxic exhaust gases when the exhaust fan is not powered up at engine start-up due to power failure by means of one-way ambient airflow tailpipe adapter that employs a high temperature silicone check valve at the nozzle connection to seal off the backwash of toxic exhaust gases when vehicle is connected to the exhaust extraction system.
4. Substantially airtight exhaust extraction systems must employ ambient air induction to cool hot gases down to save the life of the flexible hose and exhaust fan motor bearings.
5. Exhaust system hose drops shall be the same cross sectional diameter as the vehicle tailpipe or greater. Also, exhaust system shall maintain CFM that matches the cfm of the vehicle engine exhaust when running at 1500 RPM. Hose drops that do not match the size of the tailpipe and the cfm of the engine’s exhaust shall not be accepted.
6. The purpose of this portion of the specification is to ensure that the exhaust system is designed to cool down hot exhaust gases as they are conveyed to the outside of the fire station. This type of exhaust extraction keeps exhaust temperatures within a safe limit to ensure that flexible hoses are within their designed temperature tolerances. Exhaust systems that size exhaust drops without dilution ventilation and also downsize the exhaust connection hose unnecessarily put our vehicle engine warranty at risk

D. Overall System Performance

1. System must be designed solely for high temperature vehicle exhaust fire rescue applications. The system shall automatically activate, disconnect, shutdown, and reactivate during an emergency situation without human operation.

E. System Warranty

1. Complete exhaust system warranty shall be for a minimum of two years.
2. Any vendor claim of proven long-term durability must be illustrated on the specific product mentioned in this specification.
3. Any System offered to the city, that adds new or nonstandard system components not normally a part of the standard design used in all other emergency vehicle response application to date, shall not be accepted

F. Turnkey Installation

1. Complete exhaust system including the exhaust fan, control box, ductwork, and extraction unit shall be proven, and field tested for a minimum of 5 years in the United States of America.
2. All system components shall be labeled with manufacturer identification.
3. Installation of Exhaust System shall be accomplished by a factory authorized installation team that specializes in the business of installing emergency response exhaust systems. Installations must be performed by installers that have been trained and certified by manufacturer.

G. Air Testing

1. The overall design shall include individual systems for each apparatus that are specifically designed for the output CFM of the apparatus engine
2. The design CFM for each vehicle shall be a minimum 600 CFM.
3. The designed CFM stated has been selected to ensure that exhaust system will not restrict airflow of exhaust gases as they are ducted to the outside of the station

H. Final Acceptance

1. At conclusion of installation of exhaust system all vehicles in the facility will be operated for a period of 15 minutes to ensure that extraction hose, ducting, and fan have been sufficiently sized for all the vehicles operating in the fire station by providing negative pressure from the connection nozzle to the exhaust fan

I. Method of Nozzle Attachment

1. The exhaust system shall be attached to the vehicle within 3 feet of the door threshold.
2. The system shall be designed so that attachment to exhaust hose is accomplished by the operator standing erect and with one simple motion connect system to vehicle.

J. Method of Nozzle Release

1. The disconnection of the hose shall not be speed dependent and have a balancer that lifts the exhaust nozzle off the vehicle tailpipe. The nozzle must separate from the tailpipe at the same point each time regardless of the speed of the vehicle.
2. Any auto-release system that is speed sensitive requiring the driver to modify the exit speed to control the nozzle release, shall not be accepted. Any nozzle requiring support systems such as compressed air or electrical support to operate, or release shall not be accepted.
3. The intent of this portion of the specification is to reduce the amount of exhaust gases that will backwash into the station house due to early release of vehicle tailpipe or reduce the risk of violent or non-release if the driver outruns a trip mechanism.
4. The major benefit of this portion of the specification is to extend the life of the exhaust hose due to less stress at release of vehicle tailpipe.

K. Suction Rail

1. The suction rail system shall be comprised of Rail Sections which shall have aluminum top profile length of ten feet (10’). Material shall be 6063-T-5 with a standard mill finish.
2. The aluminum rail shall be constructed from a one-piece continuous extruded aluminum profile. Construction shall be 6” round in diameter, with guide rails on each side to accommodate the external trolley assembly, and a slotted profile in the top for leg and

support bracing. Rail wall thickness shall be 0.150. An opening of 3” along the bottom of the rail, shall incorporate slots on each side to accept a pair of molded neoprene rubber seals. Seals shall be installed into the bottom of the rail, to seal the tube and prevent the escape of exhaust gases while being extracted. A vacuumed form ABS molded end cap shall incorporate in its design, both an end cap feature and a hose connection

3. The end cover will seal off the ends of the rail. The total weight of these rail sections shall be 6 lbs. per foot.
4. The system shall further have suspension attachments, which shall be placed a maximum of 10' apart, for the purpose of rail support, and will be mounted in pairs from roof beams or brackets.
5. Connection to a fan shall be by means of a direct connection, thru molded end cap or by fabricated sheet metal plenums. When plenums are used, connections are made on top or sides of the rail. The complete rail system shall provide means of exhaust extraction, for vehicles moving within a work area.

L. Suction Rail Crab (Trolley) Assembly

1. The trolley assembly shall be of external guide rail design. The assembly shall be designed and constructed, using a tube frame assembly with removal outer side assemblies, and finished in a powder coated blue
2. Four Delron wheels, using oil less bearing design, shall insure long life and allow the trolley assembly to roll freely along the external guide rails. System crabs or trolleys that incorporate wheels that roll inside the suction rail will not comply and will be rejected.
3. The chasse shall include a fitted cone assembly, designed to part the memory sealing lips. The cone assembly shall be designed with a series of friction rollers. These rollers shall be designed to reduce the resistance between the memory lips and the cone assembly.
4. The trolley shall be fitted with a front and rear rubber bumper, designed to eliminate metal-to-metal contact, which otherwise might cause damage to the assemblies.

M. Crab Inlet Plenum

1. Plenum shall be designed and manufactured from 16 gauge CRS with a powder coated silver finish. A balancer attachment ring shall be fabricated in the center of plenum, to insure complete balance and weight distribution.
2. The attachment ring shall connect the balancer to the crab assembly. This design and feature will ensure that the downward force exerted on the wheels shall be evenly distributed, to ensure long life to the trolley assembly and produce the most efficient overall operating results. The plenum shall incorporate an isolation damper, insuring a positive fan startup.

N. Adjustable Shock Absorber End Stop Assembly

1. Shock absorber assembly shall incorporate an adjustable pneumatic cylinder, capable of reducing the forward impact of the trolley assembly, without causing damage to either the suction rail or the trolley assembly.
2. The assembly must be designed to have adjustable movement throughout the entire length of the rail. The assembly shall be designed to allow for a full stop of trolley (trolleys) in less than 6”.
3. A rubber bumper shall be located on the trolley assembly and designed as a contact point. The pneumatic cylinder shall be equipped with a rubber bumper end stop. Both bumpers shall be assigned to align upon impact, and at no time shall metal to metal or plastic to metal contact be allowed.

O. The System Balancer

1. System balancer shall be calibrated and certified to carry the hose weight and have the capability to pull nozzle off the vehicle tailpipe by using a 0.80 stainless steel aircraft cable no more than 40” in length.
2. The purpose of this portion of the specification is to have a rugged specially designed system balancer peel the nozzle from the vehicle tailpipe.

P. Extraction System Exhaust Hose

1. The flexible exhaust hose is manufactured for the sole purpose of venting high temperature exhaust gases which are produced by internal combustion engines
2. Flexible Hose Shall be high temperature synthetic rubber impregnated into a high temperature laminated fabric with Helix wire spacing equaling 3/4" apart, continuing throughout the entire hose, with a minimum thickness of Helix wire equaling 0.080, and including a minimum overlapping thickness of 2 7/16".
3. This construction of hose must be capable of operating at a continuous temperature of 400°F and intermittent temperatures of 500°F.
4. The exhaust hose diameter shall be a minimum of 5 inches depending on the size of the vehicle engine and corresponding exhaust pipe diameter. Hoses that are 4 inch in diameter will not be tolerated. Hose diameters of 5 inches and greater lessen internal air stream temperature and friction loss within the system which allows for greater air delivery by the fan.
5. Hoses shall be individually sized for each bay depending on the types of vehicles that are to be used in the bay that the Exhaust system is installed. The exhaust hose shall not have any pieced together connections so as to avoid diesel exhaust leakage.
6. Any exhaust system that relies on static regain from the vehicle engine or uses the engine horsepower to push the hot exhaust gases into the exhaust system shall not be accepted. Any ventilation system design that allows for hose a diameter smaller than the vehicle tailpipe shall not be accepted.
7. The sole purpose of this requirement is to ensure that the exhaust hose that is used for this application is rightly applied to the purpose of venting hot exhaust gases directly to the outside of the station house. This benefits the department by extending the life of the exhaust hose which is affected the most in source capture systems

Q. Universal Nozzle

1. Engineered and specially designed exhaust system nozzle (female connection) that is specifically designed to fit tightly over the circumference of an engineered mating ring (male connection) that attaches to the tail pipe and attaches tightly around the ring to capture 100% of the carcinogenic diesel exhaust fumes.
2. Incorporated in the rubber boot are 4 to 8 powerful rare earth magnets which are strategically located inside two sets of metal pole pieces that pivot in and out to allow for smooth release of vehicle tailpipe.
3. This allows smooth positioning of the nozzle over the mating ring to produce a required substantially airtight seal, eliminating backwash of diesel exhaust fumes into the station.
4. The release of the nozzle shall be activated by a forward motion of an apparatus simultaneously causing a lifting and backward motion of the release nozzle. This action shall institute a simple mechanical release. The simple release shall be based solely on the upward pull of the system balancer, which causes the pole pieces to pivot on the tailpipe radius and release over the flared end of the tailpipe.

R. Aluminum Transition Elbow Assembly

1. The nozzle shall be fitted to Cast Aluminum Elbow Transition, manufactured from 319 aluminum and incorporating a 62° degree curved angle. A special rag screen channel cast into the elbow shall allow for easy installation of replaceable non-static preformed

spring steel rag screen with black oxide finish. A large 7" inlet opening shall incorporate a 1" mounting flange with molded locating pin for easy and accurate installation of rubber boot assembly. Aluminum elbow assembly shall be offered in all hose sizes, 4, 5 and 6 inch.

2. Removal spring wire rag screen must be performed spring steel oxide treaded finish. Allows for easy removal

S. Tailpipe Adapter

1. Tailpipes that are connected to the system shall be retrofitted with a tailpipe adapter (male end). The tailpipe adapter allows the nozzle (female end) to fit tightly against the outer edge of the mating ring on tailpipe adapter.
2. The ring shall contain a series of machined 3/4" oval holes placed around the circumference of the ring which allows cool ambient air to enter into the exhaust hose reducing the temperature of the diesel exhaust, and thereby extending the life of the exhaust hose.
3. The circumference of the mating ring shall have a one-way silicon check valve rated at a minimum 600 degrees that opens or closes depending on the exhaust system airflow condition, when air pressure is either positive or negative. When the exhaust system is in a positive mode, the one way check valve will press against the holes on the ring and close off the ambient air intake. This will prevent any backflow of diesel exhaust into the firehouse. When air pressure in the nozzle is negative, which is the normal condition, a silicone check valve will remain open and will prevent any harmful carcinogenic materials from back washing into the apparatus bay and/or filtering into the living areas as well as cool the exhaust temperatures. Ambient air introduction at the nozzle/tailpipe adaptor will also protect the apparatus engine from backward spinning of its turbo charger when the fan is activated by another vehicle engine startup located in the adjacent bay and that apparatus is not operational. This will occur because the fan will pull air from around the tailpipe connection rather than the vehicle engine compartment

T. Flex Hose Track System Details

1. The FLEX-HOSE TRACK SYSTEM shall incorporate a lightweight aluminum track support system to convey the exhaust hose from door threshold to vehicle park position. The aluminum track shall be of box lock design with two cross supports for rigidity. Systems that use steel unistrut or aluminum H track design are not acceptable. The bottom section of the box lock track shall carry the roller clips that will support the horizontal flex-hose.
2. Horizontal Hose Drop shall consist of 5' hi-temp hose supported by a 90-degree lifting elbow, attached to balancer with a short hose attached to trolley assembly. Trolley shall incorporate a 6 x 5 galvanized steel reducer. Lower 2' hose shall incorporate handle for easy attachment to apparatus.
3. Horizontal hose shall be 6" diameter with a galvanized steel external helix. Hose material shall be Hypalon coated polyester fabric. Hose compression ratio shall be 6:1 the horizontal extraction hose shall be suspended from the guide track, which stores the hose up and out of the way to ensure a safer approach to the apparatus during a run or other activity. The horizontal hose shall be capable of withstanding temperature of 370 and above. This hose shall be supported every 12 inches using hose carrier trolleys and carrier clamps. This design eliminates hose loops and can be used in all tight quarters as designated in the bid. Any system using a hose loop in these designated bays is not acceptable.

U. Exhaust Fan Overview

1. The exhaust fan shall be sized for a minimum of 600 CFM per extraction. The induction of ambient air at the tailpipe connection shall insure that the exhaust temperature at the fan will less be then 150 degrees at the fan motor. Blower curve information for the motor/ blower combination being supplied MUST be included in the submittal information.
2. Each exhaust fan shall be designed specifically for the fire station with these factors being addressed:

    a. The size and total number of vehicles being attached to exhaust fan.
    b. The overall design of fire & emergency vehicle bays.
    c. The location of the living quarters.
    d. The existing electrical phase
    e. The physical location of the fire station in the community that is served by the fire department (The sound

3. The exhaust fan shall be sized for a minimum of 600 CFM per extraction unit unless larger or smaller vehicles are being attached to exhaust system. The induction of ambient air at the tailpipe connection shall insure that the exhaust temperature at the fan will less be then 150 degrees at the fan motor.
4. The sound decibels generated by the fan motor and impeller shall not exceed 81 Db at 5 feet. A silencer is recommended for applications greater than this to further lessen noise levels.
5. No motor that allows exhaust temperatures in excess of 200 degrees shall be accepted, this requirement insures long life the exhaust fan motor and bearings.
6. Pump Checks Option: System shall allow for pump checks to be conducted indoors. System shall allow for pump checks to be conducted for 15 minutes or more without damage to the system. Exhaust fan system shall provide negative pressure from system nozzle connection to exhaust fan inlet ductwork.

V. Fan Airflow Criteria

1. Shall be designed as a pre-engineered exhaust fan designed for the sole purpose of exhausting Volatile Organic Compound (VOC) and carcinogenic compounds generated by internal combustion engines designed to propel any motor vehicle.
2. The exhaust fan should operate automatically only during the point of when electrical power is administered to the totally enclosed fan motor.
3. Blower wheel design shall be backward inclined with minimum horsepower motor to produce the desired results for optimum efficiency and long term viability. Operating static pressure to be 6” water column.
4. Fan shall be capable of delivering a minimum of 600 CFM at 6” negative static pressure for 5” diameter hose drops.
5. Fan will not be designed with static regain from vehicle engine to assist in meeting the performance criteria mentioned in next paragraph. At no point shall the diameter of the hose drop be less then diameter of vehicle tailpipe.

W. Physical Fan Data

1. Fan housing shall be heavy gauge welded steel construction suitable for temperatures up to 250 degrees. Housings shall be provided with drilled inlet and discharge flanges. The discharge flange shall be “full flange” design.
2. The housing frame shall be constructed with four flat sides to allow for discharge change to vertical or horizontal positions with disassembly of unit.
3. Fan Impeller blower wheel shall be backward curved single thickness aluminum blade design.
4. Welds on fan housing shall be performed by a factory qualified personnel who have met the requirements of ASME Section IX. .

5. The first resonant speed of each rotor shall be not less than 125 percent of normal operating.
6. Rotor shall be two plane dynamically balanced to a maximum final vibration level of 1.0 mil.
7. Fan Motor shall be UL listed and manufactured by a readily available nationally recognized motor manufacturer. Motor shall be a permanently sealed and lubricated motor. Motor shall be supplied as a totally enclosed fan cooled or non-ventilated type with a readily available NEMA frame from 56-145Tand designed for an application where standard use is intermittent starts on average of ten times per day.
8. Fan Motor base frame shall be constructed with four flat sides to allow for discharge to change from vertical or horizontal positions without disassembly of fan housing.
9. Motor bearings shall be heavy duty anti-friction, self-aligning ball or roller bearings with positive shaft locking.
10. Fan Motor Vibration Isolation shall be manufactured as a complete assembly to assure the least possible vibration or movement. Fan wheel shall be both statically and dynamically balanced.
11. Fan Motor Power shall be 3 phase whenever readily available in station. Single phase shall only be used when the cost of providing 3-phase power becomes prohibitive or when adequate supply of usable breakers is not available or otherwise instructed by the city.
12. Fan Motor Labeling and Identification must bear the same manufacturers name as the primary exhaust ventilation equipment and electrical controller operating it. Also listed on labeling shall be model number, RPM, pressure, inlet size, outlet size, temperature limitations, Brake Horsepower (BHP), CFM, class, and any warning labels or instructions required by Underwriter's laboratories (UL).

X. System Ductwork

1. All galvanized ductwork shall be spiral G-90 galvanized pipe and shall be a minimum of 26-gage pipe sizes for 4" – 8" in diameter, 24-gage pipe for sizes 8.5" – 15" in diameter, and 22-gage pipe for sizes 16" – 22" in diameter.
2. Duct Seals on the connection shall be with 400-degree silicone. Brazing and welding at joints are not required because duct system is designed for 7" of negative pressure and at these pressures the silicone sealant is sufficient to seal the system. The lateral fittings shall be brazed or welded and must be designed with a minimum 45 degree branch taps for a smooth convergence of a two or more airstreams.
3. If duct system is designed for more than 7" static pressure than welding, brazing, and additional mechanical seals shall be required for the sole purpose that ductwork is used as an extension of the exhaust pipe and at times is placed under positive pressure.

Y. Auto Start Control System

1. Shall be designed to sense the output pressure which is normally generated by any internal combustion engine designed to operate any gas or diesel engine. The operating logic must be designed to complete this cycle. When the nozzle is connected to the vehicle's exhaust tailpipe and the vehicle is started by the operator an automatic controller, senses the increased output pressure and energizes the exhaust fan. A low voltage timer will keep the exhaust fan operating for a period of time designated by fire department procedures.
2. Electrical Controller must be UL listed/approved and manufactured in accordance with Underwriters Laboratories standard UL-508 for enclosed industrial control panels and incorporate a limited energy control circuit.
3. Control Panel enclosure must be NEMA 4X rated and UL standard 508A (CSA standard 22.2 No 14) Fiberglass material must meet the UL 746C standard.

4. System control unit mounted electrical enclosure to restrict access of internal components of controller by only authorized entry.
5. Electrical contractor shall be Allen Bradley industrial electrical contractor provided with the appropriate adjustable overload relays to meet the proper full load amperage of motor it is designed to control. Contactor must conform to the following standards: BS-5424, VDE0660, and approved by UL certification as an approved component.
6. Controller transformer to be UL listed industrial control circuit transformer with primary and secondary fuse blocks. Transformer must be provided with multi-tap primary 208V through 480V, AC, and 24V through 120V secondary.
7. Controller timer shall be solid state, 60.-min variable timer. Operating logic must complete this cycle. Input voltage is applied to the timer at all times. Upon closure of a normally open isolated start switch, the load energizes and remains energized as long as the switch is closed. When the start switch opens, the timing cycle starts. At the end of the present time delay, the load de-energizes and the timer is ready for a new timing cycle. Timer must be UL recognized component under file number E65038.
8. System pressure sensor must be engine pressure sensing type capable of recognizing the output pressure of any type of motor vehicle. Electrical contact must be dry type and not exceed 24V.
9. Stop/Start Switch located on exterior of Controller shall be a red illuminated contact button. This device must meet UL type 4X rating. Indicator light/start button must be mounted on the enclosure cover and be identified by engraved ledger plate.
10. Shall be provided and secured permanently to the exterior of electrical controller, indicating the manufacturer, their address and telephone number, user instructions and any warnings or cautions required by Underwriter Laboratories.
11. Controller Supplier will fully guarantee a minimum of two-year warranty on parts. Exceptions are obvious misuse and/or abuse to the system.
12. Shall be offered with optional Wireless low-voltage Sensor operation.
13. Shall be offered with optional Ignition Start wireless control from apparatus if required.

Z. Point of Origin

1. Equipment shall be manufactured by a U.S. Company that is headquartered in the United States of America. All components shall be American Standard. All standards of quality must be meet and adhered to including but not limited to: UL, NFPA, AMCA, IMC, ASME, UMC, NEC and all local and state building codes.
2. Company providing the exhaust venting system must have a U.S.A. ISO 9001:2008 current certification. A copy of the document must be provided with the bid package.

2.8 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Ceiling Units: Suspend units from structure; use allthread and unistrut.

C. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26.

D. Connect wiring according to Division 26.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION 233423

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Adjustable bar registers.

B. Related Sections:

1. Division 23 Section "Air Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include 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.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 Refer to schedule on drawings for types and configuration.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 23 51 23 - GAS VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Listed double-wall vents.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.

B. Shop Drawings: For vents.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 LISTED TYPE B AND BW VENTS

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. American Metal Products.
2. Cleaver-Brooks.
3. FAMCO.
4. Hart & Cooley Inc.
5. Heatfab Saf-T Vent.
6. Industrial Chimney Company.
7. LSP Products Group, Inc.
8. M&G DuraVent, Inc.; a member of the M&G Group.
9. Metal-Fab, Inc.
10. Schebler Co. (The).
11. Security Chimneys International.
12. Selkirk Corporation.
13. Tru-Flex Metal Hose Corp.
14. Van-Packer Company, Inc.

B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F (248 deg C) continuously for Type B or 550 deg F (288 deg C) continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.

D. Inner Shell: ASTM B 209 (ASTM B 209M), Type 1100 aluminum, ASTM B 209 (ASTM B 209M), Type 3003 aluminum, ASTM B 209 (ASTM B 209M), Type 3105 aluminum or ASTM A 666, Type 430 stainless steel.

E. Outer Jacket: Galvanized or Aluminized steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

3.3 INSTALLATION OF LISTED VENTS

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

B. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Lap joints in direction of flow.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 235123

SECTION 235523.13 - LOW-INTENSITY, GAS-FIRED, RADIANT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes low-intensity, gas-fired, forced-draft radiant heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of high-intensity, gas-fired, radiant heaters, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired, radiant heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Igniter: One hot-surface burner igniter(s) for each style of high-intensity, gas-fired, radiant heater furnished.

1.7 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. Burner Assembly: Three years.
b. Combustion and Emitter Tubes: Five years.
c. Heater Controls: One year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. CSA certified, with CSA Seal and certification number clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

B. UL listed and labeled, with UL label clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

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.

2.2 FORCED-DRAFT HEATERS

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. Calcana Industries Ltd.
2. Combustion Research Corp.
3. Detroit Radiant Products Company
4. Roberst-Gordon LLC
5. Schwank Inc
6. Solaronics Inc
7. Space-Ray; div of Gas Fired Products Inc
8. Sterling HVAC Products; a Mestek company
9. Thomas & Betts Corp; a member of the ABB group

B. Description: Factory-assembled, indoor, overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

C. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

D. Burner Assembly:

1. Combustion-Air Inlet: Ducted horizontal to outdoors through sidewall with vent caps, if shown.
2. Combustion-Air Inlet: Ducted vertical to outdoors through roof with vent caps, if shown.
3. Burner Control Housing: Stainless steel or Corrosion-resistant, aluminized steel.

    a. Totally enclosed with stainless-steel or steel access cover.
    b. Sight glass for visual inspection of burner.
    c. Finish: Enameled finish or powder-coated finish.

4. Burner: Stainless steel or One-piece cast iron.
5. Ignition System: Silicon carbide hot-surface igniter or Direct spark 24/25-V ac with flame rod sensing capabilities and self-diagnostic control module.
6. Combustion Blower Fan: Dynamically balanced, direct-driven, forward-curved fan with cast-aluminum-alloy or stainless-steel impeller and aluminized-steel housing, with a minimum temperature rating of 450 deg F (232 deg C).
7. Motors:

    a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.
    b. 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.

E. Combustion Chamber: 4-inch- (100-mm-) diameter, 12-gage, stainless or hot-rolled-steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Chambers shall be equipped with sight glass for burner and pilot flame observation.

F. Emitter Tube: 4-inch- (100-mm-) diameter, 12-gage, calorized, aluminized hot-rolled or stainless-steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Emitter tubing shall be equipped with baffles to maximize heating efficiency.

1. Tubing Connections: Stainless-steel threaded couplings, Interlocking flare joints with stainless-steel draw bolts or Compression couplings made from aluminized or stainless steel.
2. 90 or 180-degree-bend emitter steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.
3. Exhaust Vent Termination: Vertical through roof or Horizontal though side wall as shown on drawings with vent caps.

G. Reflector: Polished aluminum, Polished stainless steel or High-grade steel with a heat- and corrosion-resistant, hot-bonded, aluminum-silicon alloy coating, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.

H. Accessories:

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
2. Protective grilles mounted to reflectors to protect emitter tubing.
3. Stainless-steel flexible connector with manual valve for gas supply.
4. Hanger chain with "S" hooks.

5. Rigid mounting kits.
6. Clearance warning plaque.

I. Capacities and Characteristics: As scheduled on drawings.

2.3 CONTROLS AND SAFETIES

A. Gas Control Valve: two-stage, regulated redundant 24-V ac gas valve that contains pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

B. Failure Safeguards: 100 percent shutoff of gas flow in the event of flame or power failure.

C. Prepurge of air control system prior to burner ignition.

D. Safety lockout of burner after three consecutive ignition failures or flame is not reestablished within trial ignition period.

E. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.

F. Control Panel Interlock: Stops burner if panel is open.

G. Indicator Lights: "burner-on" indicator lights.

H. Thermostat: Programmable, two-stage, wall-mounted type with 50 to 90 deg F (10 to 32 deg C) operating range, relays, etc., necessary to control up to six units.

1. Control Transformer: Integrally mounted as required.

2. Relay Kit: Externally mounted. One relay kit for each heater.

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.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 INSTALLATION

A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to NFPA 54 and International Fuel Gas Code.

B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments.

1. Restrain the unit to resist seismic acceleration.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Maintain manufacturers' recommended clearances for combustibles.

3.3 CONNECTIONS

A. Gas Piping: Comply with Section 231123 "Facility Natural-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 according to NFPA 54 and International Fuel Gas Code.

B. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.

C. Vent Connections: Comply with Section 235123"Gas Vents."

D. Electrical Connections: Comply with applicable requirements in Division 26.

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

E. Controls: Wire units to programmable t-stats in groups.

3.4 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. 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.

3.5 ADJUSTING

A. Adjust initial-temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired, radiant heaters.

END OF SECTION 235523.13

SECTION 23 55 33.16 - GAS-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes gas-fired unit heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired unit heater.

1. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For gas-fired unit heaters. Include plans, elevations, sections, and attachment details.

1. Prepare by or under the supervision of a qualified professional engineer detailing fabrication and assembly of gas-fired unit heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of gas-fired unit heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Lennox International Inc; Lennox International.
2. Modine Manufacturing Company.
3. Reznor/Thomas & Betts Corporation.
4. Sterling HVAC products; Div of Mestek Technology Inc.
5. Trane; a brand of Ingersoll Rand.

2.2 PERFORMANCE REQUIREMENTS

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

B. Capacities and Characteristics: As scheduled on drawings.

2.3 MANUFACTURED UNITS

A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

B. Gas Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

C. Type of Venting: Powered vented. Separated combustion

D. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.

1. External Casings and Cabinets: Baked enamel or Powder coating over corrosion-resistant-treated surface.
2. Discharge Louvers: Independently adjustable, horizontal blades.

E. Accessories:

1. Four-point suspension kit.
2. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.

F. Heat Exchanger: Stainless steel.

G. Burner Material: Stainless steel.

H. Propeller Unit Fan:

1. Formed-steel or Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
2. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

I. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Enclosure Materials: Rolled steel.
3. Motor Bearings: Sealed.
4. Efficiency: Premium efficient.

J. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

1. Gas Control Valve: Single stage.
2. Ignition: Electronically controlled electric spark with flame sensor.
3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
4. Vent Flow Verification: Differential pressure switch to verify open vent.
5. Control transformer.
6. High Limit: Thermal switch or fuse to stop burner.
7. Wall-Mounted Thermostat:

a. Single stage.
b. Fan on-off-automatic switch.
c. 24-V ac.
d. 50 to 90 deg F (10 to 32 deg C) operating range.

K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54 and IFGA, applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Threaded Rods, Spring Hangers, and Building Attachments: Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Anchor the unit to resist code-required horizontal acceleration.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.

C. Gas Piping: Comply with Section 231123 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Provide flue with cleanout, roof thimble and cap of materials recommended by manufacturer.

E. Ground equipment according to Division 26.

F. Connect wiring according to Division 26.

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. 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 unit heater will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

END OF SECTION 235533.16

SECTION 23 72 23 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fixed-plate total heat exchangers.
2. Packaged energy recovery units.

1.3 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment 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. Filters: One set(s) of each type of filter specified.
2. Fan Belts: One set(s) of belts for each belt-driven fan in energy recovery units.

1.6 QUALITY ASSURANCE

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

B. 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 according to 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, "Nonducted Heat Recovery Ventilators."
2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

1.7 COORDINATION

A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of 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.
2. Warranty Period for Fixed-Plate Total Heat Exchangers: 10 years.

PART 2 - PRODUCTS

2.1 FIXED-PLATE TOTAL HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

1. Mitsubishi Electric Sales Canada, Inc
2. RenewAire LLC

B. Casing: Galvanized steel. G90 with polyester urethane paint

C. Plates: Evenly spaced and sealed and arranged for counter airflow.

1. Plate Material: Chemically treated paper with selective hydroscopicity and moisture permeability, and gas barrier properties.

D. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.
2. 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 lift out from access plenum.
3. Factory-fabricated, dry, extended-surface type.
4. Thickness: 2 inches (50 mm).
5. Minimum Arrestance: 90, according to ASHRAE 52.1.
6. MERV: 8, according to ASHRAE 52.2.
7. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
8. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.2 PACKAGED ENERGY RECOVERY UNITS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

1. Des Champs Technologies
2. Greenheck Fan Corp
3. Loren Cook Company
4. Mitsubishi Electric Sales Canada
5. RenewAire LLC
6. Venmar CES Inc
7. Aaon

B. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed and calked weathertight, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1-inch- (25-mm-) thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

1. Inlet: Weatherproof hood, with damper for exhaust and supply.

a. Exhaust: Spring-return, two-position, motor-operated damper.
b. Supply: Spring-return, two-position, motor-operated damper.

2. Roof Curb:

D. Heat Recovery Device: Total energy recovery wheel as specified in 2.1 above.

E. Supply and Exhaust Fans: Forward-curved, centrifugal fan with flexible duct connections.

1. Motor and Drive: Direct driven with EISA compliant premium efficiency motor.
2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency for premium efficiency motors, ODP.
3. 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.
4. Isolators on each fan.

F. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.
2. 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 lift out from access plenum.
3. Factory-fabricated, dry, extended-surface type.
4. Thickness: 2 inches (50 mm).
5. Minimum Arrestance: 90, according to ASHRAE 52.1.
6. MERV: 8, according to ASHRAE 52.2.
7. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
8. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

G. Condensate Drain Pans:

1. Shall not be required with OAT above -10°F and IA Rh of 40% or below

H. Wiring: Fabricate units with space within housing for electrical conduits. Wire motors and controls so only external connections are required during installation.

1. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
2. Include fused disconnect switches.

I. Accessories:

1. Roof Curb: Galvanized steel with gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches (350 mm).
2. Intake weather hood with 2-inch- (50-mm-) thick filters.
3. Exhaust weather hood with birdscreen.
4. Isolation Dampers: Double-skin, airfoil-blade, galvanized-steel, aluminum or extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed-blade arrangement with steel operating rods rotating in stainless-steel sleeve, , bearings mounted in a single galvanized-steel, aluminum or extruded-aluminum frame, with operating rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. (0.22 L/s per sq. m) at 1-inch wg (250 Pa) and 9 cfm/sq. ft. (0.4 L/s per sq. m) at 4-inch wg (1.0 MPa).
5. Duct flanges.
6. Rubber-in-shear isolators for ceiling-mounted units.
7. Hinged access doors with quarter-turn latches.
8. Electric Duct Heater and Control: provide SCR modulating controller with discharge duct stat.

2.3 CONTROLS

A. Time Clock: Solid-state, programmable, microprocessor-based unit for wall mounting with up to eight on/off cycles per day and battery backup protection of program settings against power failure to energize unit.

2.4 CAPACITIES AND CHARACTERISTICS

A. As scheduled 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. Install ERV so supply and exhaust airstreams flow in opposite directions.

B. Equipment Mounting:

C. Roof Curb: Install on roof structure or concrete base, level and secure, according to The NRCA "Roofing and Waterproofing Manual - Volume 4: Construction Details - Low-Slope Roofing," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07. Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing.

D. Install wind and seismic restraints according to manufacturers' written instructions.

E. Install units with clearances for service and maintenance.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

A. Interlock unit with duct heater so heater can’t operate if unit is not on.

B. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

C. 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. 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. 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.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. 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 237223

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged, small-capacity, rooftop air-conditioning units (RTUs) with the following components and accessories:

1. Casings.
2. Fans.
3. Motors.
4. Coils.
5. Refrigerant circuit components.
6. Air filtration.
7. Gas furnaces.
8. Dampers.
9. Electrical power connections.
10. Controls.
11. Accessories.
12. Seismic roof curbs.

1.3 DEFINITIONS

A. DDC: Direct digital controls.

B. ECM: Electronically commutated motor.

C. MERV: Minimum efficiency reporting value.

D. 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.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, small-capacity, rooftop air-conditioning 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.

1.4 ACTION SUBMITTALS

A. Product Data: For each RTU.

1. Include manufacturer's technical data.
2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

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

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Fan Belts: One set(s) for each belt-driven fan.
2. Filters: One set(s) of filters for each unit.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or 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 five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. AHRI Compliance:

1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested according to AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

C. 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, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Comply with applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. NFPA Compliance: Comply with NFPA 90A or NFPA 90B.

F. UL Compliance: Comply with UL 1995.

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

2.2 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:

1. AAON.
2. Carrier Corporation; a unit of United Technologies Corp.
3. Daikin Applied.
4. Lennox Industries, Inc.; Lennox International.
5. Trane.
6. YORK; a Johnson Controls company.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: RTUs, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2.4 CAPACITIES AND CHARACTERISTICS

A. As scheduled on drawings.

2.5 CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. 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.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: G-90-coated galvanized steel, 0.034 inch (0.86 mm) thick.

D. Corrosion-Resistant Coating: Apply a corrosion-resistant coating capable of withstanding a 3,000-hour salt-spray test according to ASTM B 117.

1. Standards:

a. ASTM B-117 for salt spray.
b. ASTM D-2794 for minimum impact resistance of 100 in-lb ((11.3 N-m).)
c. ASTM B-3359 for cross-hatch adhesion of 5B.

2. UV Protection: Spray-applied topcoat.

E. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1/2 inch (13 mm).
3. Liner materials shall have airstream surface coated with 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.

F. Plastic Condensate Drain Pans: Fabricated using rigid heavy plastic polymer, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1 for design and construction of drain pans.

G. Condensate Drain Pans: Fabricated using G-90-coated galvanized-steel sheet 0.028 inch (0.70 mm) thick or stainless-steel sheet 0.025 inch (0.715 mm) thick, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1 for design and construction of drain pans.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple.

H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.6 FANS

A. Supply-Air Fans: Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

1. Belt-Driven Supply-Air Fans: Motors shall be installed on an adjustable fan base resiliently mounted in the casing.

B. Condenser-Coil Fan: propeller, mounted on shaft of permanently lubricated motors.

C. Relief-Air Fan: Forward curved, VFD controlled lubricated motor by space pressure sensor.

2.7 MOTORS

A. Comply with Section 230513 "Common Motor Requirements for HVAC Equipment" and the requirements of this Article.

B. 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.

C. Service Factor: 1.15.

D. Motor Bearings: Greaseable.

2.8 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coils from contacting steel coil frame or condensate pan.

B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coils from contacting steel coil frame or condensate pan.

2.9 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.

2.10 AIR FILTRATION

A. Minimum arrestance and MERV according to ASHRAE 52.2. MERV 8

2.11 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.

E. Gas Valve Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.12 DAMPERS

A. Leakage Rate: Comply with ASHRAE/IES 90.1.

B. Damper Motor: Modulating with adjustable minimum position.

2.13 ELECTRICAL POWER CONNECTIONS

A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.14 CONTROLS

A. Programmable t-stat with 7 day program and heat/cool/auto fan subbase.

B. Basic Unit Controls:

1. Control-voltage transformer.
2. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.
3. Unoccupied Period:

    a. Heating Setback: 10 deg F (5.6 deg C).
    b. Cooling Setback: System off.
    c. Override Operation: Two hours.

4. Supply Fan Operation:

    a. Occupied Periods: Run fan continuously.
    b. Unoccupied Periods: Cycle fan to maintain setback temperature.

5. Refrigerant Circuit Operation:

    a. Occupied Periods: Cycle or stage economizer and compressors to match output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure.
    b. Unoccupied Periods: Compressors off.

6. Gas Furnace Operation:

    a. Occupied Periods: Stage or modulate burner to maintain room temperature.
    b. Unoccupied Periods: Cycle burner to maintain setback temperature.

7. Economizer Outdoor-Air Damper Operation:

    a. Occupied Periods: Open to 10 percent fixed minimum intake, and maximum 100 percent of the fan capacity. Controller shall permit air-side economizer operation when outdoor air is less than 78 deg F. Use outdoor-air enthalpy to adjust mixing dampers. Start relief-air fan with pressure sensor in space, modulate fan to maintain space pressure. During economizer cycle operation, lock out cooling.
    b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

2.15 ACCESSORIES

A. Factory-installed, demand-controlled ventilation.

B. Coil guards of painted, galvanized-steel wire.

C. Outdoor-air intake weather hood with moisture eliminator.

D. Oil separator.

2.16 ROOF CURBS

A. Provide seismic spring isolated roof curbs with vibration isolators and wind or seismic restraints.

B. Curb Dimensions: Height of 14 inches (355 mm) above roof.

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 or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Or AHRI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate 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 Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

C. Where installing piping adjacent to RTUs, allow space for service and maintenance.

1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

D. Connect electrical wiring according to Division 26.

E. Ground equipment according to Division 26.

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 tests and inspections with the assistance of a factory-authorized service representative.

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. RTU will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to furnace combustion chamber.
4. Inspect for visible damage to compressor, coils, and fans.
5. Inspect internal insulation.
6. Verify that labels are clearly visible.
7. Verify that clearances have been provided for servicing.
8. Verify that controls are connected and operable.
9. Verify that filters are installed.
10. Clean condenser coil and inspect for construction debris.
11. Clean furnace flue and inspect for construction debris.
12. Connect and purge gas line.
13. Remove packing from vibration isolators.
14. Inspect operation of barometric relief dampers.
15. Verify lubrication on fan and motor bearings.
16. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
17. Adjust fan belts to proper alignment and tension.
18. 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.

19. Inspect and record performance of interlocks and protective devices; verify sequences.
20. Operate unit for an initial period as recommended or required by manufacturer.
21. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency:

a. Measure gas pressure on manifold.
b. Inspect operation of power vents.
c. Measure combustion-air temperature at inlet to combustion chamber.
d. Measure flue-gas temperature at furnace discharge.
e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

22. Calibrate thermostats.
23. Adjust and inspect high-temperature limits.
24. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
25. 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.

26. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
27. 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.

28. 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.

29. 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.

30. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. 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.

END OF SECTION 237416.11

SECTION 23 81 26 - SPLIT-SYSTEM HEAT PUMP AIR-CONDITIONERS - DIRECT EXPANSION (DX), AIR-COOLED, VARIABLE CAPACITY, SPLIT SYSTEM

Part 1 – GENERAL

SPLIT SYSTEM AIR CONDITIONING

1.1 SYSTEM DESCRIPTION

A. The air conditioning system shall be a heat pump split system as specified. The system shall consist of evaporator, brazed joints and headers, a two pipe refrigeration distribution system using PID control and variable speed condensing unit. The condenser shall be a direct expansion (DX), air-cooled heat pump air-conditioning system with variable speed inverter driven compressor using R-410A refrigerant.

B. The indoor units shall be connected to the condensing unit utilizing brazed piping per manufacturers requirements to ensure correct refrigerant flow and balancing. T style joints are not acceptable. Nitrogen purge during brazing.

C. Operation of the system shall permit cooling or heating of each indoor unit. Each indoor unit shall be able to provide set temperature via a local controller.

D. Approved Manufacturers: Daikin, Mitsubishi, LG

1.2 FEATURES AND BENEFITS

A. Voltage Platform – condensing units capacity and voltage shall be as scheduled on drawings.

B. Independent Control – Each indoor unit shall use a dedicated electronic expansion valve with 2000 positions for independent control.

C. VFD Inverter Control – Each condensing unit shall use high efficiency, variable speed all “inverter” compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.

Indoor units shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.

D. Low Ambient Cooling – Each system shall be capable of low ambient cooling operation to -4°F DB.

E. Independent Control – Each indoor unit shall use a dedicated electronic expansion valve for independent control.

F. Oil Return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle

G. Simple Wiring – Systems shall use 16/18 AWG, 2 wire, multi-stranded, non-shielded and non-polarized daisy chain control wiring.

H. Outside Air – Systems shall re-use OA from ERV.

I. Low Sound Levels – Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).

1.3 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.

B. All wiring shall be in accordance with the National Electric Code (NEC).

C. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

D. Mechanical equipment for wind-born debris regions shall be designed in accordance with ASCE 7-2010 and installed to resist the wind pressures on the equipment and the supports.

E. The condensing unit will be factory charged with R-410A.

1.4 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.05 WARRANTY

STANDARD LIMITED WARRANTY

Manufacturer shall warrant original owner of the products free from defects in material and workmanship including compressor and all parts with a ten (10) year warranty starting from the ''installation date'' which is:

a. The date that the unit is originally commissioned.

Part 2 – PRODUCTS

2.01 CONDENSING UNIT

A. General: The condensing unit is designed specifically for use with indoor components.

1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator.
   Liquid and suction lines must be individually insulated between the condensing and indoor units.
2. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
3. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.

4. The unit shall incorporate an auto-charging feature. Manual changing should be supported with a minimum of 2 hours of system operation data to ensure correct operation.
5. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
6. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
7. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation.
8. The condensing unit shall be capable of heating operation at -13°F wet bulb ambient temperature without additional low ambient controls or an auxiliary heat source.

B. Unit Cabinet:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:

1. The condensing unit shall consist of one or more propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The fan shall be a vertical or horizontal discharge configuration.
3. Nominal sound pressure levels shall be less than 65 db(A)
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. Condenser Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.
5. The outdoor coil shall have three-circuit heat exchanger design eliminating the need for bottom plate heater. The lower part of the coil shall be used for inverter cooling and be on or off during heating operation enhancing the defrost operation.

E. Compressor:

1. The inverter scroll compressors shall be variable speed (inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. The compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value. Non inverter-driven compressors, which may cause starting motor current to

exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” or “J-type”.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The compressors’ motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
5. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
6. Oil separators shall be standard with the equipment together with an intelligent oil management system.
7. The compressor shall be spring mounted to avoid the transmission of vibration eliminating the standard need for spring insolation.

F. Electrical:

1. The power supply to the condensing unit shall be as scheduled on drawings.

2.02 2x2 CASSETTE UNIT

A. General: Indoor unit shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with a 4 way decoration panel grille. The decoration panel shall be a four way air distribution type, with fresh white color, impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. Sound pressure shall range from 25.5 dB(A) to 33 dB(a) at low speed measured at 5 feet below the unit.

B. Indoor Unit:

1. Unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be fully insulated from the outdoor unit or nearest branch connection into the refrigerant network
4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter and return air thermometer.
6. The indoor units shall be equipped with a condensate pan and condensate pump with built in safety shutoff and alarm.

C. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling
2. Three auto swing position shall be available to choose from via field setting

3. The airflow of the unit shall have the ability to shutdown one or two sides allowing for simpler corner installation
4. Fresh air intake shall be direct connected to the side of the unit cabinet.
5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

D. Decoration Panel

1. The decoration panel shall be a four-way air distribution type and constructed of impact resistant polymer in white and shall fit into a standard 2x2 ceiling grid with no overlap of adjacent tiles.
2. The four air discharge outlet louvers shall be independently motorized and controllable. Each louver shall have a visual indicator to easily identify the louver and simplify the airflow configuration.
3. The louver outlets shall be capable of closure to allow for 3-way and 2-way air distribution.
4. The decoration panel shall be a low profile design, extending 5/16” below the ceiling.

E. Fan:

1. The fan shall be driven by a direct-drive DC motor with statically and dynamically balanced impeller and shall have three user selectable speeds available: high, medium, and low.
2. The airflow rate shall be available in high, medium, and low settings.
3. When unit is connected with I-Touch Manager, the auto fan mode shall be selectable.

F. Filter: The return air shall be filtered by means of a washable long life filter with mildew proof resin.

G. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 22 FPI design completely factory tested
4. The refrigerant connections shall be flare connections and the condensate will be PVC.
5. A condensate pan shall be located under the coil
6. A condensate pump with a 24-13/16” lift, measured from the drain outlet, shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

H. Electrical: A separate power supply and separate control wiring is provided from outdoor unit.

I. Control:

1. The unit shall have controls provided to perform input functions necessary to operate the system.

J. Optional Accessories

1. VISTA Decoration panel – white
2. Direct fresh air intake kit

3. Wired remote NAV controller BRCIE73 wall with integral timeclock
4. Adaptor for wiring
5. Wiring adaptor for electrical appendices as required.
6. KRP – Board to control auxiliary electric heat through relay. Coordinate with electrical.

2.03 WALL MOUNTED UNIT

A. General: Indoor unit shall be a wall mounted fan coil unit, operable with refrigerant R-410A equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 31 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.

B. Performance: Each unit's performance is based on nominal operating conditions as scheduled on drawings.

C. Indoor unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through a resin net mold resistant filter.
5. The indoor units shall be equipped with a condensate pan.
6. The indoor units shall be equipped with a return air thermistor but controlled from room t-stat.

D. Unit Cabinet:

1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 14 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC.
5. A thermistor will be located on the liquid and gas line.
6. A condensate pan shall be located in the unit with lift pump

G. Electrical:

1. Power supply will be provided from outdoor unit.

H. Control:

1. The unit shall have controls provided to perform input functions necessary to operate the system.

I. Provide the following:

1. Remote wall mounted IR remote in wall bracket
2. A condensate pump
3. High condensate alarm

2.04 ROOM SENSORS

A. General: the local remote control shall be made from plastic materials with a neutral color. Each controller shall have a LCD (Liquid Crystal Display) that shows setpoint, setpoint adjustment, room temperature, mode of operation (on/off/cool/heat), and fan speed.

2.05 ELECTRICAL CHARACTERISTICS

A. General: Each indoor unit control circuit board shall supply 16 volts DC to the local remote controller. The voltage may rise or fall in relation to the transmission packets that are sent and received.

B. Wiring: The control wiring shall be terminated in a daisy chain design from outdoor unit, to branch selector, then daisy chaining to each indoor unit in the system and terminating at the farthest indoor unit. The remote control wiring shall run from the indoor unit control board terminal block to the remote controller connected to that indoor unit.

C. Wiring Size: Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable and 18 AWG stranded copper wire.

2.06 NAVIGATION REMOTE CONTROLLER (WALL STAT)

A. Navigation (NAV) Remote Controller (Wall Stat): The NAV remote controller shall provide control for all VRV indoor units. The remote controller wiring consists of a non-polar two-wire connection to the indoor unit at terminals P1/P2. The NAV remote controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s). The NAV remote controller does not need to be addressed.

B. Mounting: The NAV remote controller shall be mounted into a standard 2”x4” junction box.

C. Display Features:

1. Backlit LCD display with contrast adjustment and auto off after 30 seconds.
2. Display language shall be selectable from English, French or Spanish.
3. Selectable display – detailed, standard and simple
   a. Detailed Display: Shall display Operation Mode, Cool, Heat and Setback setpoints, Fan Speed, Louver position, Room Temperature, Time and Day of the Week.
   b. Standard Display: Shall display Operation Mode, Cool, Heat and Setback setpoints and Fan Speed.
   c. Simple Display

      i. Shall display Operation Mode, Cool, Heat and Setback setpoints, Fan Speed and Room Temperature.
      ii. The room temperature shall be displayed with a large 11/16” font.
4. All displayed items configurable:

   a. Configure “Off” to be displayed when unit is turned off (field setting required)

      i. Prevents mode adjustment

   b. Setpoint can be removed from display when unit is turned off (field setting required)

      i. Prevents setpoint adjustment

   c. Fan speed display removable (field setting required)

      i. Prevents fan speed adjustment.

5. System Status icons
6. The controller shall display temperature setpoint in one degree increments with a range of 60-90°F
7. Detailed and Simple display will reflect room temperature (0-176°F range in one degree increments).

   a. Display of temperature information shall be configurable for Fahrenheit or Celsius

8. On/Off status shall be displayed with an LED
9. Error codes will be displayed with a two digit code in the event of system abnormality/error.

   a. A blinking LED will also signal system abnormality/error

10. The following system temperatures can be displayed to assist service personnel in troubleshooting.

    a. Return Air Temperature
    b. Liquid Line Temperature
    c. Gas Line Temperature
    d. Discharge Air temperature (depending on unit)
    e. Remote controller sensor temperature
    f. Temperature used for indoor unit control
    g. Room temperature

D. Basic Operation:

1. Controller shall control the following operations:

    a. On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto*). Configure only the essential modes to be selectable- remove unnecessary mode selection(s) from display.
    b. Independent cooling and heating setpoints in the occupied mode. Dual setpoints (individual cool and heat setpoint switch minimum setpoint differential 0-7°F default 2°F or single setpoint.
    c. Independent cooling setup and heating setback setpoints in the unoccupied mode.
    d. Fan Speed: Up to 5 speeds (dependant on indoor unit types)
    e. Vane direction and oscillation (dependent on indoor unit type)

        i. Airflow Direction: Up to 5 louver positions and auto swing
        ii. Individual airflow: Provides individual control of up to four louvers on an indoor unit
        iii. Dual airflow: provides control of both internal and external louver positions.
        iv. Automatic draft protection: Automatically prevents airflow from blowing directly on occupants.

2. The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period.
3. Function button lockout (on/off, mode, fan speed, up/down, left, right arrows).
4. Optional controller Face Decal to hide unnecessary (locked out) buttons
5. Indoor unit group assignment
6. Filter indicator: Filter service indicator shall be displayed after 100, 1250 or 2500 default hours of run time configurable via field setting.
7. Clock (12/24 hour) and day display
8. Automatic adjustment for Daylight Savings Time (DST): Set changeover period (second Sunday in March/first Sunday in November)

E. Programmability:

1. Controller shall support schedule settings with selectable weekly pattern options.

    a. 7-day
    b. Weekday + Weekend
    c. Weekday + Saturday + Sunday
    d. Everyday
    e. The schedule shall support unit on/off
    f. Independent settings for cooling and/or heating setpoints when unit is on (occupied).
    g. Independent setup (cooling) and setback (heating) setpoints when unit is off (unoccupied).
    h. A maximum of 5 operations can be schedulable per day
    i. Time setting in 1-minute increments

2. The controller shall support auto-changeover mode for heat pump, therefore, allowing the optimal room temperature to be maintained by automatically switching the indoor units mode between cool and heat according to the room temperature and temperature setpoint.

a. Changeover to cooling mode shall occur at cooling setpoint +1°F as the primary changeover deadband and takes the guard timer into consideration. Configurable from 1-4°F.
b. Changeover to cooling mode shall occur at the primary changeover deadband to cooling +1°F as the secondary changeover deadband. Configurable from 1-4°F.
c. Changeover to heating mode shall occur at heating setpoint -1°F as the primary changeover deadband and takes the guard timer into consideration. Configurable from 1-4°F
d. Changeover to heating mode shall occur at the primary changeover deadband to heating -1°F as the secondary changeover deadband. Configurable from 1-4°F.
e. 1 hour guard timer

    i. Upon changeover, guard timer will prevent another changeover during this period.
    ii. Guard timer is ignored by a change of setpoint manually from either the multi-zone controller, remote controller or by schedule.
    iii. The guard timer is also ignored if the space temperature reaches the secondary changeover deadband (configurable from 1-4°F from the primary changeover deadband, and the guard timer has been activated.)
    iv. 60 minutes as default, configurable to 15, 30 or 90 minutes.

f. The controller shall support the auto-setback by sensor function (dependent on indoor unit type). The cooling and heating setpoints shall gradually relax (configurable) internally when the room is determined to be unoccupied.

    i. The internal setpoint shall return to the original setpoint when room occupancy is detected.

g. The controller shall support the Filter Auto Clean function to be performed once a day (dependent on indoor unit type).

    i. Eight (8) time periods (00:00-03:00, 03:00-06:00, 06:00-09:00, 09:00-12:00, 12:00-15:00, 15:00-18:00, 18:00-21:00, 21:00-00:00) shall be available to select from to enable the automatic filter cleaning function.

        a. Default time period (00:00-03:00) shall be used if the period for filter auto cleaning is not specified.

    ii. The indoor unit shall be stopped during auto filter cleaning function operation.

h. The controller shall support an auto off timer for temporarily enabling indoor unit operation during the unoccupied period.

    i. When the off timer is enabled and when the unit is manually turned on at the remote controller.
    ii. The controller shall shut off the unit after a set time period.
    iii. The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments.

End Section 238126

SECTION 23 82 16.14 - COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes electric resistance air coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

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

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

A. Altitude above Mean Sea Level: 2800 feet

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 COILS

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. Brasch Manufacturing Co., Inc.
2. Chromalox.
3. Dunham-Bush, Inc.
4. INDEECO.
5. Trane.

B. Testing Agency Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Coil Assembly: Comply with UL 1995.

D. Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.

E. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.

1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

F. Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) thick for slip-in mounting.

G. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:

1. Control transformer
2. Toggle switches; one per step.
3. SCR Step controller with discharge air setpoint t-stat. Duct mounted
4. Time-delay relay.
5. Pilot lights; one per step.
6. Airflow proving switch.
7. Relay as needed to interface with fan coil and/or ERV

H. Control from fan coil and/or controller. Coordinate as required.

I. Capacities and Characteristics: As scheduled on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Ground equipment according to Division 26.

B. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

END OF SECTION 238216.14

SECTION 238239.19 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Berko; Marley Engineered Products.
2. Chromalox, Inc.
3. Indeeco.

4. Markel Products Company; TPI Corporation.
5. Marley Engineered Products.
6. Ouellet Canada Inc.
7. QMark; Marley Engineered Products.
8. Trane Inc.

2.2 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

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

2.3 CABINET

A. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection and factory mounted disconnect.

2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated.

2.6 CONTROLS

A. Controls: Unit-mounted thermostat or if shown with remote t-stat, provide low-voltage relay with transformer kit.

B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.7 CAPACITIES AND CHARACTERISTICS

A. As scheduled on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. 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 according to Division 26.

E. Connect wiring according to Division 26.

END OF SECTION 238239.19

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS:

A. All drawings associated with the entire project, including general provisions of the Contract, including The General Conditions of the Contract for Construction, General and Supplementary Conditions and Division-1 Conditions specification sections shall apply to the Division 26 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with the aforementioned and all other Contract Documents associated with the project.

B. Where contradictions occur between this section and Division 1, the more stringent requirement shall apply.

C. Contractor shall be defined as any and all entities involved with the construction of the project.

1.2 SUMMARY:

A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26 and Division 28. It expands and supplements the requirements specified in sections of Division 1 through 50.

1.3 ELECTRICAL INSTALLATIONS:

A. Drawings are diagrammatic in character and do not necessarily indicate every required conduit, box, fitting, etc.

B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.

C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.

D. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.

E. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.

F. Before any work is begun, determine that equipment will properly fit the space and that conduit can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.

G. Verify all dimensions by field measurements.

H. Arrange for chases, slots, and openings in other building components to accommodate electrical installations.

I. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring an access path for positioning prior to closing-in the building or space.

J. Where mounting heights are not detailed or dimensioned, install electrical conduits, boxes, and overhead equipment to provide the maximum headroom possible. In general, keep installations tight to structure.

K. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components as much as practical, and connect equipment for ease of disconnecting and removal with minimum of interference with other installations.

L. Make allowance for expansion and contraction for all building electrical components and conduit systems that are subject to such.

M. The ceiling space shall not be “layered”. It is the contractor’s responsibility to offset and coordinate any systems as required to allow installation within the identified ceiling cavity. The contractor shall include labor and material in the base bid to accommodate such offsets.

N. In general, all conduit systems shall be routed as high as possible. Keep all equipment in accessible areas such as corridors and coordinate with systems and equipment from other sections.

O. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

P. Coordinate the installation of electrical materials and equipment above and below ceilings with suspension system, luminaires and other building components. Ductwork and piping shall not be installed above electrical panelboards, switchboards, motor control centers, and transformers.

1.4 COORDINATION:

A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for preparing coordination drawings, showing all work, in all areas. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, hangers, control devices, lighting, low voltage equipment, cable tray, conduit, transformers, disconnects, etc., necessary to overcome congested conditions at no increase in contact sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.

B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project. Coordination shall include, but not be limited to the following:

1. Fire Alarm Contractor shall provide shop drawings to other Contractors as required.

2. Automatic Temperature Controls, Building Management and Testing, Adjusting and Balancing Contractors shall be provided with equipment product data and shop drawings from other Division 23 and Division 26 Contractors and shall furnish the same information involving control devices to the appropriate Contractor.
3. Automatic Doors and controls, Elevators and other building access equipment shall have cut sheets reviewed and shall furnish the same information to the appropriate Contractor.

C. Coordination Drawings:

1. Coordination drawings shall be prepared by the Contractor for his utilization and are his responsibility to assure systems will be installed in a manner to allow all systems to function properly.
2. Prepare and submit a set of coordination drawings showing major elements, components, and systems of electrical equipment and materials in relationship with other building components. Prepare 24”x36” or 30”x42” drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for servicing and maintaining equipment. Indicate movement and positioning of large equipment into the building during construction.
3. Coordination drawings are informational submittals. Submit coordination drawings to Engineer for information only to document proper coordination of all portions of work and that coordination issues have been identified and resolved prior to submitting to the Engineer and prior to commencing construction in each affected area. The review of the coordination drawings by the Engineer does not constitute a relief of responsibility of the Contractor or a change to the contract documents. The Contractor shall have sole responsibility in developing a fully coordinated and integrated ceiling cavity.
4. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

    a. Electrical equipment room layouts
    b. Mechanical equipment room layouts

5. Clearly indicate solutions to space problems. Identification of space problems without solutions is not acceptable. Only areas clearly identified will be reviewed.
6. All coordination drawings shall be 3D, with provision for collision check. The contractor is responsible for obtaining the architectural and structural files in 3D, if not available, the contractor shall develop them from the 2D architectural and structural drawings. All 3D drawing development, collision check, coordination, etc. shall be included as part of the Contractors base bid.
7. Prepare coordination drawings and other Shop Drawings at a suitable scale, showing the required dimension. In addition to the mentioned areas and systems above, also submit specific equipment installations, including, but not limited to the following:

    a. Utility Connections
    b. Generators and automatic transfer switches
    c. Pad mounted transformers
    d. Switchboards and panelboards
    e. Equipment connections
    f. Control panels
    g. Circuit and motor disconnects
    h. Feeder conduits

8. CADD Drawings: Electronic AutoCAD drawings are available for purchase by the Contractor from the Engineer. Contact Engineer for further information in acquiring

CADD drawings. The Engineers Construction documents cannot be used directly for coordination drawings. They are for information and initial coordination only.

9. Wiring Diagrams: Provide wiring diagrams indicating: field installed electrical power; control wiring; cabling layouts; overcurrent protective devices; equipment, and equipment connections.

1.5 COORDINATION WITH OTHER DIVISIONS:

A. General:

1. Coordinate all work to conform to the progress of the work of other trades.
2. Complete the entire installation as soon as the condition of the building will permit. No extras will be allowed for corrections of ill-timed work, when such corrections are required for proper installation of other work.

B. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electrical systems within the cavity space allocation in the following order of priority:

1. Equipment and required clearances
2. Plumbing waste, cooling coil drain piping and roof drain mains and leaders.
3. Ductwork mains.
4. Plumbing vent piping.
5. Low pressure ductwork and air devices.
6. Electrical and communication conduits, raceways and cable tray.
7. Domestic hot and cold water.
8. Hydronic piping.
9. Fire sprinkler mains, branch piping and drops (locate as tight to structure as possible).
10. DDC control wiring and other low voltage systems.
11. Fire alarm systems.

C. Chases, Inserts and Openings:

1. Provide measurements, drawings and layouts so that openings, inserts and chases in new construction can be built in as construction progresses.
2. Check sizes and locations of openings provided, including the access panels for equipment in hard lid ceilings and wall cavities.
3. Any cutting and patching made necessary by failure to provide measurements, drawings and layouts at the proper time shall be done at no additional cost in contract sum.

D. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other sections of the specifications can be built at the proper time.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

F. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

G. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attentions to changes required in other work as result of modifications shall be paid for by responsible Contractor/Subcontractor.

1.6 DESIGN WORK REQUIRED BY CONTRACTOR:

A. The construction of this project requires the Contractor to include the detailing and design of several systems and/or subsystems. All such design work associated with the development of the coordination drawings shall be the complete responsibility of the Contractor.

B. The Contractor shall take the full responsibility to develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers contract drawings shall be for system design intent and general configurations.

C. Systems or subsystems which require design responsibility by the contractor include but are not limited to:

1. Temporary Facilities.
2. Utility Company Coordination details.
3. Final coordinated distribution systems within the ceiling cavity.
4. Any system not fully detailed.
5. Fire alarm shop drawings.
6. Equipment supports, hangers, anchors and seismic systems not fully detailed nor specified in these documents, or catalogued by the manufacturer.
7. Seismic restraint systems.

1.7 PROJECT CONDITIONS:

A. The contractor shall be required to attend a pre-bid walk-thru if required and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.

B. Field verify all conditions prior to submitting bids.

C. Report any damaged equipment or systems to the Owner prior to any work.

D. Protect all work against theft, injury or damage from all causes until it has been tested and accepted.

E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

F. The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections.

G. Provide temporary electrical connections where required to maintain existing areas operable.

H. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, at a minimum one week in advance.

I. Minimize disruptions to operation of electrical systems in occupied areas.

1.8 SAFETY:

A. Refer to Division 1.

1.9 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:

A. Refer to Division 1 and conform with the Owners requirements.

1.10 REQUIREMENTS OF REGULATORY AGENCIES:

A. Refer to Division 1.

B. Execute and inspect all work in accordance with Underwriters Laboratories (UL), and all local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the more stringent requirement shall be followed. Follow application sections and requirements and testing procedures of NFPA, IEEE, NEMA, CBM, ANSI, NECA, ICEA, NETA, and IETA.

C. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

D. Energy Codes: All equipment and installations shall conform to Federal, State, and local Energy Conservation Standards.

E. The handling, removal and disposal of regulated liquids or other materials shall be in accordance with U.S. EPA, state and local regulations.

F. The handling, removal and disposal of lead based paint and other lead containing materials shall comply with EPA, OSHA, and any other Federal, State, or local regulations.

G. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

H. All material used on this project shall be UL listed and labeled and be acceptable to the authority having jurisdiction as suitable for the use intended.

1.11 REQUIREMENTS OF LOCAL UTILITY COMPANIES:

A. Comply with rules and regulations of local utility companies. Include in bid the cost of all meter boxes, meters and such accessory equipment which will be required but not provided by Local Utility Company for the project.

B. Utility Connections:

1. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
2. The contract documents indicate the available information on existing utilities and services and on new services (if any) to be provided to the project by utility companies and agencies. Notify Engineer immediately if discrepancies are found.

3. Coordinate electrical utility interruptions at least one week in advance as approved in writing with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.
4. Nominal System Voltages have been identified on the contract documents. Coordinate and install relay settings, circuit breaker settings, generator output settings, transformer taps, etc. with measured utility voltage obtained from the Utility. Identify Phase rotation and other parameters with Shop Drawings for Service Entrance Equipment Submittals.
5. Provide Utility Company approved equipment and install all CT enclosures/bus, conduit and wiring, meter sockets, connection cabinets, etc. as required by Serving Utility. Locate final Meter location in conjunction with Utility representative and coordinate with Architect/Engineer.
6. Make all applications for service including Temporary services for construction and coordinate service requirements. Arrange and pay for all Utility fees and costs of electricity until final services are transferred to owner.
7. Document final phase rotation, voltages on each phase, neutral and ground currents and voltages once serving Utility services are connected at service entrance location. Adjust tap, relay, and other settings as necessary for delivered Utility electric services. Submit final configurations and values with Testing and Equipment Settings Report.

1.12 PERMITS AND FEES:

A. Refer to Division 1.

B. Contractor shall pay all fees required for connection to municipal and public utility facilities.

C. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.

1.13 PROJECT SEISMIC REQUIREMENTS:

A. Installation shall comply with the local seismic requirements for the area of installation. Provide restraints, bracing, anchors, vibration isolation, seismic snubbers, and all other components required for the installation.

B. All electrical and fire alarm systems shall be installed to meet NFPA and IBC Seismic requirements.

1. Where any conflicts arise the more stringent requirements shall be applicable.
2. The design of the seismic requirements shall be the responsibility of the contractor.

1.14 TEMPORARY FACILITIES:

A. Light, Heat, Power, Etc. Responsibility for providing temporary electricity, heat and other facilities shall be as identified in these specifications, as shown on the drawings and as specified in Division 1.

B. Building distribution equipment and devices (existing or new) shall not be used without written permission of the Owner. If used for temporary power, the equipment shall be properly maintained and any damage resulting from use shall be repaired by the Contractor. The guarantee period for new equipment shall not begin until the equipment is turned over to the Owner.

C. If AC power systems or their backup systems serving telecommunications, computer equipment, or their associated HVAC equipment and controls are taken out of service, for any reason, the Contractor shall be responsible for providing temporary systems during the period when the AC power systems or their backup systems are out of service. The Contractor shall be responsible for providing temporary power to all loads being interrupted.

1.15 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. Refer to the Instructions to Bidders and Division 1.

B. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.

C. Materials and equipment of equivalent quality may be submitted for substituted prior to bidding. This may be done by submitting to the Architect/Engineer at least ten (10) working days prior to the bid date requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.

1. Substitutions shall be allowed only upon the written approval of the Architect/Engineer NO EXCEPTIONS.
2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications or which does not have prior approval.

1.16 SUBMITTALS:

A. General

1. Refer to the Conditions of the Contract (General and Supplementary), Division 1.
2. Contractor shall provide a submittal schedule appropriate for the size and schedule of the project. Limit the number of large submittals being reviewed at one time and coordinate timing of sections that are dependent on each other i.e. submit coordination and short circuit study prior to or together with gear, overcurrent protection devices, ATS, etc.
3. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.
4. The front of each submittal package shall be identified with the specification section number, job name, Owner's project number, date, Prime Contractor and Subcontractor’s names, addresses, and contact information, etc. Each Specification Section shall be submitted individually and submittal shall be tabbed for the equipment/materials/etc. within the section. Submittals that are not complete with the required information will not be reviewed and will be sent back to be corrected.
5. Submittals shall be provided electronically. All electronic submittals need to be complete with all design information and stamped for conformity by the contractor. Submittals will be reviewed, marked appropriately and returned by the same means received.
6. An index shall be provided which includes:

a. Product
b. Plan Code (if applicable)
c. Specification Section
d. Manufacturer and Model Number

7. Submittal schedule shall be provided for review within four (4) working weeks from award of contract to successful bidder.

B. Basis of Design: The manufacturer's material or equipment listed first in the specifications or on the drawings are the basis of design and are provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the first names, the cost of any changes in construction required by their use shall be borne by this Contractor.

C. All equipment shall conform to the State and/or local Energy Conservation Standards

D. Contractor Review: Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Each submittal shall be reviewed by the contractor for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Architect/Engineer. Any submittal not stamped or complete will be sent back. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed unless written prior approval is obtained by the Contractor.

E. Submittal Review Process: Before starting work, prepare and submit to the Architect/Engineer shop drawings and descriptive product data required for the project. Continue to submit in the stated format after each Architect/Engineer's action until a "No Exception Taken" or "Make Correction Noted" action is received. When a "Make Corrections Noted" is received, make the required corrections for inclusion in the operation and maintenance manual (O&M). Submittals marked "Make Corrections Noted" shall not be resubmitted during the submittal process. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned "Revise and Resubmit". Where an entire submittal package is returned for action by the Contractor, the Engineer may summarize comments in letter format and return the entire set. Submittals shall be prepared per the ELECTRICAL SUBMITTAL CHECKLIST, at the end of this section; supplemental requirements are listed in each Division 26 Section.

F. The Design Professional’s review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:

1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
2. Construction means or methods
3. Coordination of the work with other trades
4. Construction safety precautions

G. The Design Professional’s review shall be conducted with reasonable promptness while allowing sufficient time in the Design Professional’s judgment to permit adequate review. Review of a specific item shall not indicate that the Design Professional has reviewed the entire assembly of which the item is a component.

H. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing

by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.

I. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.

J. If more than two submittals (either for product data, shop drawings, record drawings, test reports, or O&M's are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

K. The contractor shall cloud all changes made on submittals that are marked "Revise and Resubmit."

L. Required Submittals: Provide submittals for each item of equipment specified or scheduled in the contract documents. See table at the end of this section.

M. Submit letters certifying compliance with ANSI standards for medium or high voltage gear. These letters shall be signed by a corporate officer and shall list applicable standards. Letters signed by local representatives will not be acceptable.

N. Submit proposed changes to electrical room or other equipment room layouts when revised from contract documents prior to installation.

O. Mark submittals with designations as shown on the drawings and identify as required by Specification Sections. Identification shall contain the information as required in details and each label shall be submitted in list form with disconnects, MCC's, panelboards, switchboards, overcurrent protection devices and utilization equipment.

1.17 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:

A. Product Listing:

1. Prepare listing of major electrical equipment and materials for the project, within (2) two weeks of signing the Contract Documents and transmit to the Architect

   a. Provide all information requested.
   b. Submit this listing as a part of the submittal requirement; see Paragraph 1.15 "PRODUCT OPTIONS AND SUBSTITUTIONS."

2. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.
3. When two or more items of same material or equipment are required (lighting, wiring devices, switchgear, panelboards, protective devices, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials steel bar stock, welding rods, solder, fasteners, except as otherwise indicated.

   a. Provide products which are compatible within systems and other connected items.

4. For conduit, wire and fittings, the Contractor shall select a prime and alternate manufacturer from the list of acceptable manufacturers provided in the appropriate sections of this Division. The prime and alternate manufacturers shall be identified in the product listing. The contractor shall make every effort to use the prime manufacturer for

the entire project. If products from this manufacturer are unavailable, the Contractor shall use the listed alternate with the following provisions.

a. Wire: All wire placed in a single conduit or installed in multiple conduits making up parallel feeders shall be of the same manufacturer.
b. Conduit and Fittings: All conduits and fittings installed exposed within the same room or immediate area shall be of the same manufacturer.

B. Schedule of Values

1. Provide Preliminary Schedule of Values to Engineer with product data submittal within four (4) weeks from award of contract to successful bidder. Provide according to the following descriptions:

a. General Construction (total)
b. Service/Distribution
c. Lighting - Interior
d. Lighting – Exterior
e. Lighting Controls
f. Basic Materials/Devices/Equipment Connections (Mechanical)
g. Emergency Generator
h. Fire Alarm (Material/Installation)
i. Security
j. P.A./Sound/Intercom

2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.

C. Product Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
2. Delete or mark-out portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:

a. Sizes.
b. Weights.
c. Speeds.
d. Capacities.
e. Conduit and electrical connection sizes and locations.
f. Statements of compliance with the required standards and regulations.
g. Performance data.
h. Manufacturer's specifications.
i. Housing and proposed Finishes.
j. NEMA or other ratings that apply.

5. Checklist: Where identified in ELECTRICAL SUBMITTAL CHECKLIST or within individual Division 26 Sections or necessary for confirmation of products, submit a detailed checklist which acknowledges compliance or a reason for non-compliance to each of the specification requirements. Arrange the checklist according to the headings of each item identified in each specification (i.e. Shop Drawings, Wiring Diagrams,

Product requirements, individual line items, etc.) Mark items as "N/A" where the item is not applicable.

D. Shop Drawings:

1. Shop Drawings are defined as electrical system layout drawings prepared specifically for this project, or fabrication and assembly type drawings of system components to show more detail than typical pre-printed materials.
2. Prepare Electrical Shop Drawings, except diagrams, to accurate scale, min 1/8”-1'-0", Electrical rooms shall be ¼”-1’-0”unless otherwise noted.
3. Shop drawings shall include:

    a. Proposed equipment installations.
    b. Electrical characteristics and connection requirements.
    c. Clearance dimensions at critical locations.
    d. Dimensions of spaces required for operation and maintenance.
    e. Interfaces with other work, including structural support.
    f. Elevations when necessary in areas with multiple pieces of equipment on common walls or to clarify incoming/exiting methods/clearances, etc.
    g. Wall and floor penetrations.
    h. Wiring diagrams shall showing all components, internal connecting wiring, and contractor connection requirements including terminal blocks/lugs, wire sizes, etc.

E. Coordination Drawings: See separate paragraph of this specification section.

F. Test Reports:

1. Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test.
2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.
3. Submit test reports as required for O & M manuals.

G. Operation and Maintenance Data: See separate paragraph of this specification section.

H. Equipment Settings Report: Where identified in the ELECTRICAL SUBMITTAL CHECKLIST or within individual Division 26 Sections or necessary for confirmation of products, submit Equipment Settings Report for each device indicating final configurations and settings.

1. Provide report of settings, parameters, programing inputs and parameters, etc., installed at each piece of electrical equipment that allows adjustments to be made in the field and those set at the factory. The report shall be arranged by specification section and each piece of equipment broken out individually or by listing of equipment if the same settings are installed in multiple pieces of equipment.
2. In addition to the requirements above, include within this report any individual ground fault system settings; zone interlock operational settings; Arc Flash reduction schemes and levels; transfer switch settings including time delays and upstream protection device settings with copies of listed OCPD’s for each ATS; settings of monitoring equipment including trip levels and alarm levels; Generator settings and parameters; UPS settings and parameters; relay settings; transformer tap settings; phase rotation documentation; lighting control settings with associated timer settings; electrical interlock and/or kirk key system descriptions; posted operational signage; and any other pertinent information.

3. Report shall be submitted and received by the Engineer at least fifteen calendar days prior to the contractor's request for final observation. Include in the O & M Manual after review and "No Exceptions Taken" has been accomplished.

I. Software Licenses: Provide documentation of ownership under the owner's corporate name (coordinate with owner's representative for exact ownership wording) for Software Licenses provided as part of the work. Include information for updates, subscription requirements if applicable, backup, support, login, passwords, date when purchased, expiration date if applicable, version, etc. Include in the O & M Manual after review and "No Exceptions Taken" has been accomplished.

J. Record Drawings: See separate paragraph of this specification section.

1.18 DELIVERY, STORAGE AND HANDLING:

A. Refer to the Division 1, Sections on Transportation and Handling and Storage and Protection.

B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

C. Check delivered equipment against contract documents and submittals.

D. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.

E. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.19 CUTTING AND PATCHING:

A. Cutting and patching of electrical equipment, components, and materials may be required for removal and legal disposal of selected materials, components, and equipment. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

B. Refer to the Division 1 Section covering cutting and patching for general requirements.

C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.

E. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

F. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work;
2. Remove and replace defective Work;
3. Remove and replace Work not conforming to requirements of the Contract Documents;

4. Remove samples of installed Work as specified for testing;
5. Install equipment and materials in existing structures;
6. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

G. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of conductors, conduit, luminaires, boxes, devices and other electrical items made obsolete by the new Work.

H. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

I. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

J. Locate, identify, and protect electrical services passing through remodel or demolition area and serving other areas required to be maintained operational.

K. When coring is required or identified, an x-ray of the area is to be taken prior to the performance of the work operation. X-ray work requires an MOP and protection.

1.20 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough in requirements.

C. Work through all coordination before rough-in begins.

1.21 ACCESSIBILITY:

A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc. that require replacement or servicing.

B. Extend all conduits so that junction and pull boxes are in accessible locations.

C. Provide access panel or doors where equipment or boxes are concealed behind finished surfaces.

D. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification and requirements.

E. The minimum size of any access door shall not be less than the size of the equipment to be removed or 12 inches x 12 inches if used for service only.

F. Furnish doors to trades performing work in which they are to be built, in ample time for building in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.

G. Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed. In lieu of these doors, approved shop fabricated access doors with DuroDyne hinges may be used.

H. Access doors in fire rated walls and ceilings shall have equivalent U.L. label and fire rating.

1.22 TESTING:

A. Submit test reports as outlined in Division 1 Sections on Quality Control Services and each Division 26 Section.

B. Testing as required by these specifications shall pertain to all equipment, wiring, devices, etc. installed under this contract and being reused.

C. General Scope:

1. Perform all tests and operational checks to assure that all electrical equipment, both Contractor and Owner-supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.
2. The tests and operational checks shall determine the suitability for energization.
3. Schedule tests and give a minimum of two weeks advance notice to the Architect/Engineer. Reschedule testing for Owner convenience if required.

D. Test Report: Submit the completed report to the Architect/Engineer no later than fifteen (15) days after completion of test unless directed otherwise. The test report shall be bound and its contents certified. A final compilation of all Test Reports shall be submitted with the Testing and Equipment Settings Report (Refer to Operation and Maintenance Data paragraphs).

E. Each test report shall include the following:

1. Project information including: Building, name, address, date, and other pertinent information.
2. List of equipment tested.
3. Description of test.
4. List of test equipment used and calibration date.
5. Baseline, acceptable, or published target value for test with code or standard reference indicating where value was derived.
6. Test results that summarize all measured values with baseline values.
7. Conclusions and recommendations.
8. Appendix, including appropriate test forms that show all measured values.

F. Failure to Meet Test:

1. Any system material or workmanship which is found defective on the basis of performance tests shall be reported directly to the Architect/Engineer.
2. All failed tests shall be sent immediately by email to Architect/Engineer with proposed corrective action and proposed re-test date and time.

3. Contractor shall replace the defective material or equipment as necessary, and have test repeated until test proves satisfactory without additional cost to the Owner.

G. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy. The accuracy shall be traceable to the National Institute of Standards and Technology (NIST) in an unbroken chain. Instruments shall be calibrated in accordance with the following frequency schedule:

1. Field Instruments: 6 months
2. Laboratory Instruments: 12 months
3. Leased specialty equipment: 12 months. (Where accuracy is guaranteed by lessor
4. Dated calibration labels shall be visible on all test equipment.

H. Independent Testing Agency:

1. The tests and/or operational checks indicated hereinafter in these Specifications shall be performed by a recognized independent testing agency engaged and paid for by the Contractor.
2. The testing agency shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907. Membership in the National Electric Testing Association constitutes proof of meeting such criteria.
3. The testing agency shall be responsible for implementing all final settings and adjustments on protective devices in accordance with Owner's specified values.
4. Testing Agencies: Subject to compliance with requirements and qualifications, the following are accepted agencies:

   a. Emerson
   b. Grounded Technologies, Inc.
   c. ABM Electrical Power Services

5. Independent Testing Agency requirements shall apply to the following Division 26 sections:

   a. Lighting Control Devices
   b. Switchboards
   c. Low Voltage Circuit Protective Devices
   d. Transfer Switches
   e. Surge Protection Devices

6. All work described in each section under field quality control shall be accomplished by the Independent Testing Agency.

1.23 EXCAVATING AND BACKFILLING:

A. General:

1. Provide all necessary excavation and backfill for installation of electrical work in accordance with Division 2.
2. In general, follow all regulations of OSHA as specified in Part 1926, Subpart P, "Excavations, Trenching and Shoring." Follow specifications of Division 26 as they refer specifically to the electrical work.

B. Contact Owners of all underground utilities to have them located and marked, at least 2 business days before excavation is to begin. Prior to starting excavation, brief

employees on marking and color codes and train employees on excavation and safety procedures for Utilities including electrical lines and natural gas lines. When excavation approaches electrical or gas lines, expose lines by carefully probing and hand digging.

C. Trenching:

1. Provide all necessary pumping, cribbing and shoring.
2. Walls of all trenches shall be a minimum of 6 inches clearance from the side of the nearest electrical work. Install conduits with a minimum of 6 inches (or as identified on the drawings) clearance between them when located in same trench.
3. Dig trenches to depth, width, configuration, and grade appropriate to the materials being installed. Dig trenches to 6 inches below the level of the bottom of the material to be installed. Install 6 inches bed of sand, pea gravel, or squeegee, mechanically tamp to provide a firm bed, true to line and grade without irregularity. Provide depressions only at hubs, couplings, flanges, or other normal protrusions.

D. Backfilling shall not be started until all work has been inspected, tested and accepted. All backfill material shall be accepted by the soils engineer. In no case shall lumber, metal or other debris be buried in with backfill.

1. Provide warning tape for marking and locating underground utilities. Tape shall be specifically manufactured for this purpose and shall be polyethylene film, 6 inches wide, 0.004 inches thick and have a minimum strength of 1750 psi. Tape shall carry continuous inscription naming the specific utility.

a. Tape shall have magnetic strip and be used for exterior underground system only.

E. Trench Backfill

1. Backfill to 4 inches above top of conduits with sand, the same as used for conduit bed, compact properly.
2. Continue backfill to finish grade, using friable material free of rock and other debris. Install in 6 inch layers, each properly moistened and mechanically compacted prior to installation of ensuing layer. Compaction by hydraulic jetting is not permissible.

F. After backfilling and compacting, any settling shall be refilled, tamped, and refinished at contractor's expense.

G. This contractor shall repair and pay for any damage to finished surfaces.

H. Backfill near manholes or hand holes using sand, installing it in 6 inch layers to 4 inches above the shallowest conduit. Use suitable excavated material to complete the backfill, installed in 6 inch layers and mechanically compacted to seal against water infiltration. Compact to 95% below paving and slabs and 90% elsewhere.

I. Use suitable excavated material to complete the backfill, installed in 6 inch lifts and mechanically compacted to seal against water infiltration. Compact to 95 percent for the upper, 30 inches below paving and slabs and 90 percent elsewhere.

1.24 NAMEPLATE DATA:

A. Provide equipment with permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial

number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Install equipment so that nameplate is readily visible.

B. Phase Rotation

1. New Building: Provide clockwise phase rotation on this project. Provide a label at service entrance main disconnect and the generator tap box indicating phase rotation for the building.

1.25 CLEANING:

A. Refer to the Division 1 Section on project closeout or final cleaning for general requirements for final cleaning.

B. Clean all luminaires, lamps and lenses per manufacturer's recommendations prior to final acceptance. Replace all inoperative lamps.

1.26 RECORD DOCUMENTS:

A. Refer to the Division 1 Section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 1.

B. Keep a complete set of record document prints in custody during entire period of construction at the construction site. Documents shall be updated on a weekly basis.

C. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; concealed control system devices, and any other relevant deviations from the Contract Documents.

D. Mark shop drawings to indicate approved substitutions; Addenda; Change Orders; actual equipment and materials used.

E. Schedules:

1. Mark luminaire schedule on drawings to indicate manufacturer and complete catalog numbers of installed equipment.
2. Mark schedules including panelboard, switchboard, motor control center, mechanical, kitchen and similar equipment schedules on drawings to indicate installed equipment and materials used, and any deviations or revisions to electrical load data and calculations.

F. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme.

1. Red shall indicate new items, deviations and routing.
2. Green shall indicate items removed or deleted.
3. Blue shall be used for relevant notes and descriptions.

G. At the completion of the project, obtain from the Architect a complete set of the Contract Documents in a read-only electronic format (.pdf unless otherwise noted). This set will include all revisions officially documented through the Architect/Engineer. Using the above color scheme, transfer any undocumented revisions from the construction site record drawings to this complete set. Submit marked up and completed documents to

the Architect/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Architect/Engineer.

H. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up .pdf format readable by Bluebeam is preferred.

I. One full size set of record drawing one line diagrams shall be posted in the electrical room and one half size set of the remaining electrical record drawings shall be bound with 3 Hole inserts and plastic cover and stored in the electrical room.

1.27 OPERATION AND MAINTENANCE DATA:

A. Refer to the Division 1 Section on project closeout or operation and maintenance data for procedures and requirements for preparation and submittal of maintenance manuals.

B. No later than four (4) weeks prior to the completion of the project provide complete set of operating and maintenance manuals, or as specified in Sections of Division 1 (whichever is more stringent). Operation and Maintenance Data shall be submitted in electronic format.

C. Operation and Maintenance Data: Submit operation and maintenance data in maintenance manual in accordance with requirements of applicable Division 26 Sections and Division 1. Provide Operating and Maintenance Instructions in electronic format covering all equipment furnished. Manuals shall include all information required below, as indicated in each Division 26 Section, and the following for each piece of equipment:

1. The job name and address, contractor’s name, address, and phone number, and each subcontractor's name, address, and phone number shall be identified at the front of the electronic submittal.
2. Name, address and telephone number to be contacted of the local authorized service organization/company and individual to be contacted for service and maintenance for each item of equipment.
3. Submit operation and maintenance data, schedule of recommended service and parts lists for all materials and products specified and intended for installation. Include description of function, normal operating characteristics and limitations, fuse curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
4. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
6. Servicing instructions and lubrication charts and schedules.
7. Manufacturer's service manuals for all electrical equipment provided under this contract.
8. Complete equipment and protection wiring diagrams. All wiring diagrams shall show color coding of all connections and mounting dimensions of equipment.
9. Equipment identification numbers and adjustment clearly indicated for each piece of equipment.
10. Electrical System and Equipment Warranties.
11. Provide manuals tabbed and divided into major sections and special equipment. Mark the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
12. Record Set of Shop Drawings: Shop drawings corrected to show as-built conditions. Transfer modifications from field set.

13. Equipment Testing Report including all test reports and Equipment Settings Report indicating final configurations and settings.

D. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, settings reports, and final Schedule of Values with all Electrical and Information Technology change order costs included and identified is provided and the manual is reviewed by the Architect/Engineer.

1.28 PROJECT CLOSEOUT LIST:

A. In addition to the requirements specified in Division 1, complete the requirements listed below.

1. The contractor shall be responsible for providing the items listed on the Electrical Submittal Checklist prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements (Checklist is located at the end of this section.)
2. Final payment will not be authorized until all items on the final punch list have been complete.

1.29 WARRANTIES:

A. Refer to the Division 1 Section on Warranties and Bonds for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.

B. Compile and assemble the warranties specified in Division 26, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item. Information to include product or equipment description, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.30 CONSTRUCTION REQUIREMENTS:

A. The contractor shall maintain and have available at the jobsite current information on the following at all times:

1. Up to date record drawings.
2. Addenda
3. Change Orders
4. Submittals
5. Site observation reports with current status of all action items.
6. Test results; including recorded values, procedures, and other findings.
7. Outage information.

1.31 EQUIPMENT HOUSEKEEPING PADS:

A. Provide 4" concrete housekeeping pad for all floor mounted equipment including, but not limited to: switchgear, switchboards, motor control centers, floor mounted distribution panelboards, floor mounted branch panelboards, floor mounted VFD’s and starter cabinets, and floor mounted dry type transformers. Fabricate pads as follows:

1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4" larger in both directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
3. Place concrete and allow curing before installation of units. Use Portland cement that conforms to ASTM C 150, 54000-psi compressive strength, and normal weight aggregate.
4. Anchor housekeeping pads to slab using #3 rebar bent in “L” or “Z” shape 12 inch on center on each side of slab.

1.32 ELECTRICAL SUBMITTAL CHECKLIST:

A. Provide submittals including shop drawings, product data, product checklists, tests and reports, training, extra material, coordination drawings, record drawings, O&M manuals, device setting reports, and software licenses per the following schedule:

Division 26

C – Product Checklist; Q – Qualifications, CD – Coordination Drawings, RD - Record Drawings, D – Device Setting Report; S – Software License, W – Special Project Warranty

SPEC Section	TITLE	Requirements									
		Report Data		Test	Factory Test	Report	Factory Rep Supervision at Site	Training Req’d at Site	Extra Material	O&M	Other
		Shop Drawings	Product Data								
26 05 00	Common Work Results For Electrical										
	Electrical Coordination Drawings	X									
	Utility Company Final Parameters, Measurements, Equipment, and Contacts	X	X	X		X				X	D
	Seismic Design Parameters per Local Authority	X	X			X				X	
	Temporary Facilities	X	X			X					
	Product Listing		X							X	C
	Preliminary Schedule Of Values					X					
	Final Schedule Of Values					X				X	
	Electrical On-Site Metering Reports			X		X				X	
	Tests/Independent Testing	X	X	X	X	X	X	X		X	D
	Completed/Signed MOP’s					X				X	

C – Product Checklist; Q – Qualifications, CD – Coordination Drawings, RD - Record Drawings, D – Device Setting Report; S – Software License, W – Special Project Warranty

SPEC Section	TITLE	Requirements									
		Report Data		Test	Factory Test	Report	Factory Rep Supervision at Site	Training Req'd at Site	Extra Material	O&M	Other
		Shop Drawings	Product Data								
	Record Drawings including changes to existing Equip.	X								X	
	O&M Manuals	X	X	X	X	X			X	X	C,D,S
	Project Closeout List					X				X	
	Contractor/Equipment Warranties					X				X	
26 05 19	Low Voltage Electrical Power Conductors And Cables		X	X		X				X	
26 05 26	Grounding And Bonding For Electrical Systems	X	X	X		X				X	
26 05 29	Hangers And Supports For Electrical Systems	X	X							X	
26 05 33	Raceway And Boxes For Electrical Systems	X	X								CD, RD
	Electrical Metallic Tubing		X								CD, RD
	Flexible Metal Conduit		X								CD, RD
	Intermediate Metal Conduit		X								CD, RD
	Liquid-Tight Flexible Conduit		X								CD, RD
	Non-Metallic Conduit PVC		X								CD, RD
	Rigid Metal Conduit		X								CD, RD
	Surface Metal Raceway	X	X							X	CD, RD
	Wireways	X	X							X	CD, RD
	Rigid Aluminum Conduit		X								CD, RD
26 05 34	Cabinets, Boxes & Fittings	X	X								CD, RD
26 05 43	Underground Ducts And Raceways For Electrical Systems	X	X			X				X	CD, RD
	Utility Vaults	X	X							X	CD, RD

C – Product Checklist; Q – Qualifications, CD – Coordination Drawings, RD - Record Drawings, D – Device Setting Report; S – Software License, W – Special Project Warranty

SPEC Section	TITLE	Requirements									
		Report Data		Test	Factory Test	Report	Factory Rep Supervision at Site	Training Req'd at Site	Extra Material	O&M	Other
		Shop Drawings	Product Data								
	Telecommunication Vaults	X	X							X	CD, RD
	Junction Boxes	X	X							X	CD, RD
	Pull Boxes	X	X							X	CD, RD
	Transformer Box Pads	X	X								CD, RD
	Splice Pads	X	X								
26 05 53	Identification For Electrical Systems	X	X							X	
26 05 83	Wiring Connections	X	X	X							D
26 09 23	Lighting Control Devices	X	X	X		X	X	X	X	X	C CD, RD,,D,S
26 24 13	Switchboards	X	X	X	X	X	X	X	X	X	C, CD, RD, D, S
26 24 16	Panelboards	X	X	X		X			X	X	CD, RD, D
26 27 26	Wiring Devices		X	X		X				X	
26 28 00	Low Voltage Circuit Protective Devices	X	X	X		X		X	X	X	C, D.S
26 32 13	Engine Generators	X	X	X	X	X	X	X	X	X	C, CD, RD, D,S
26 36 00	Transfer Switches	X	X	X	X	X	X	X		X	C,D,S
26 43 13	Surge Protection Device	X	X	X	X	X		X		X	Q
26 50 00	Lighting	X	X	X		X			X	X	
	Ballasts, LED's, Drivers	X	X	X		X				X	W
26 56 13	Poles & Standards		X							X	
28 31 00	Fire Alarm Systems	X	X	X		X	X	X		X	C, Q, S

END SECTION 26 05 00

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SECTION 26 05 19 – LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY:

A. This section includes wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.

C. Conform to applicable code regulations regarding toxicity of combustion products of insulating materials.

1.3 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product Data: Submit manufacturer's data on electrical wires, cables and connectors.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Deliver wire and cable properly packaged in factory- fabricated type containers, or wound on NEMA-specified type wire and cable reels.

B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by the following (for each type of wire, cable, and connector):

1. Wire and Cable:

a. American Insulated Wire
b. Belden
c. Cerrowire
d. Encore Wire

e. General Cable Corporation.
f. Southwire Company
g. Okonite
h. Superior Essex:

1) Triangle
2) Excel
3) Royal

2. Connectors:

a. O-Z/Gedney Co.
b. AMP, Inc.
c. Burndy Corporation.
d. Ideal Industries, Inc.
e. 3M Company
f. Thomas and Betts Corp.

2.2 WIRES AND CABLES:

A. General: Provide wire and cable suitable for the temperature, conditions, and location where installed.

B. Conductors: Provide solid conductors and approved connectors for power, control, and lighting circuits 10 AWG and smaller. Provide stranded conductors for 8 AWG and larger.

C. Conductor Material: Use the following material for sizes indicated.

1. No. 1 AWG and Smaller and all grounding system conductors not sharing a common raceway: copper
2. No 1/0 AWG and Larger: 8000 Series electrical grade aluminum alloy 600v, except where another specific material is indicated.
3. Conductor sizes indicated on One line or schedules may be based on copper, see individual drawings for details. Sizes are based on Copper if no designation is shown, Sizes are based on Aluminum if Al is included in nomenclature. Modify conductor sizes as required to provide equivalent ampacity to indicated copper conductors. (A minus tolerance of 2 percent is permissible if ampacities remain above those shown in NEC Ampacity Tables.) Fully adapt and adjust the electrical system to size aluminum in lieu of copper. This includes, but is not limited to, the following actions:

a. Where connecting to equipment whose manufacturer requires copper conductors connection, provide copper conductors from source, i.e. circuit breaker, disconnect, etc., and provide all necessary splices, splice boxes and other devices required to satisfy manufacturer requirements. Do not otherwise intermix copper and aluminum conductors.
b. Increase conduit size and increase sizes of pull boxes, and junction boxes, and gutter space as required to accommodate larger aluminum conductors. Make structural, mechanical and other construction adjustments necessitated by these changes.
c. Assure the pulling tension rating and support requirements of the aluminum conductors is adequate for wiring runs indicated.
d. Assure that equipment at which aluminum conductors terminate is UL listed and manufacturer approved for use with aluminum and so labeled.

e. Submit to the Architect/Engineer a record of actions taken in accordance with the above including marked-up project drawings, copies of manufacturer literature and communications and written conductor re-sizing calculations.
f. Do not reduce raceway or enclosure sizes as part of the above adjustments.

4. Metal Clad Cable - Type MC: Sizes 12 AWG and 10 AWG, copper conductors with 600 volt thermoplastic insulation rated 90 degrees C, galvanized steel interlocked metal type covering. Fitting shall be steel with double grip saddle and locking nut.
5. Portable Cord:

a. Type SO: Sizes 12 AWG through 2 AWG, copper conductors with 600 volt thermoset insulation 0.1 resistant insulation.
b. Type G-GC: Sizes 1 AWG through 500 KCMIL, copper conductors with 600/2000 volt, 90 degrees C, ethylene-propylene insulation.

6. Cables: Provide the following types of cables in NEC approved locations and applications where permitted by the contract documents. Cables shall be U.L. listed and approved by the local building authority. All cables shall contain a green insulated equipment ground conductor of the same size as the neutral conductor.

2.3 CONNECTORS:

A. Description: Provide UL-type factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperatures equal to or greater than those of the wires upon which used.

B. Provide 2-hole compression lugs for all power feeder, neutral, and grounding connections when installed on bus bars. (Including phase, neutral and grounding conductors).

C. Provide connectors that are designed to accept stranded conductors where stranded conductors are used.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE:

A. Building Wire: Install all building wire in raceway regardless of location.

B. Metal Clad Cable:

1. Maximum of 6 feet unsupported length for connecting luminaires in accessible ceilings to the local junction box.
2. Maximum of 6 feet unsupported length for connecting luminaires in non-accessible ceilings to the local junction box.
3. In stud walls and casework for horizontal branch circuit runs between devices.
4. For vertical branch circuit drops from a local junction box in each room above an accessible ceiling to the direct or single device in a stud wall, casework, under counter lighting.
5. May not be used for branch circuit home runs, feeders, motor feeder circuits or in the following locations:

a. Hazardous locations
b. Emergency Systems

6. Branch circuit conductors shall match color coding schedule within this specification section.

C. Portable Cord: Use for flexible pendant leads to luminaires, outlets, and equipment where indicated and in compliance with codes.

3.2 INSTALLATION OF WIRES AND CABLES:

A. General: Install electrical cables, wires and connectors in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.

B. Coordinate wire/cable installation work, including electrical raceway and equipment connection work, with other work.

C. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.

D. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway. Do not use rope hitches for pulling attachment to wire or cable.

E. Keep conductor splices to minimum. Splice only in accessible junction boxes. No splices are allowed in feeder, control or fire alarm wiring. Connect unspliced wire to numbered terminal strips at each end.

F. Install splices and taps which possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

G. Use splice and tap connectors which are compatible with conductor material.

H. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A for copper and 486B for aluminum.

I. Support cables above accessible ceilings. Independent from the ceiling suspension system to support cables from structure, do not rest on ceiling tiles.

J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled to individual circuits. Make terminations so there is no bare conductor at the terminal.

K. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated screw on type spring wire connectors with plastic caps, push on type are not acceptable.

L. Use copper compression connectors for copper wire splices and taps, 1/0 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor.

M. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

N. Thoroughly tape the ends of spare conductors in boxes and cabinets.

O. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

P. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to individual ground terminal of devices.

Q. Branch circuits whose length from panel to first outlet exceeds 100 feet for 120 volt circuits shall be #10 or larger, as required to comply with the National Electrical Code.

R. Parallel conductors shall be cut to the same length.

S. All splices in control panels, terminal junction boxes, low voltage control circuits, fire alarm, etc., conductors shall be on numbered terminal strip.

T. Where conduit is not required, plenum rated cable shall be provided in ceiling, floor or other air plenum spaces.

U. Provide wire training, lacing, labeling, and terminal blocks as required in panelboards and all control cabinets including, but not limited to, lighting, transfer switch, fire alarm, and security cabinets. All wiring shall be installed neat and be labeled to match wiring diagrams, control devices, etc.

1. Make temporary connections to panelboard devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.

V. Color coding of switch legs, travelers, etc. shall be different and distinct from phase and neutral conductors. Where systems utilize two (2) different voltages, the color coding of switch legs, travelers, etc. shall be different and distinct for each voltage system.

3.3 FIELD QUALITY CONTROL:

A. Test installed wires and cables with 1000 VDC megohm meter to determine insulation resistance levels to ensure requirements are fulfilled. Test shall be made on all feeders regardless of size and on all branch circuits with No. 4 AWG and larger conductors. The megger values obtained shall be compared to the minimum values listed in NETA. All phase conductors and cables shall be meggered after installation, and prior to termination. Submit test report.

B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.4 COLOR CODING SCHEDULE:

A. Color code secondary service, feeder, and branch circuit conductors as follows:

120/208 Volts	Phase
Black	A
Red	B

Blue	C
White	Neutral
Green	Ground

B. Conductors shall be solid color for entire length.

C. If solid color conductor insulation is not available and specific acceptance is given by the engineer for use of black conductor insulation, provide the following:

1. Conductors 6 AWG and smaller shall be solid color for the entire length.
2. Conductors 4 AWG and larger shall have either solid color insulation as specified above for the entire length or be black with color coding at each termination and in each box or enclosure. For a distance of 6 inches use half-lapped ¾ inch plastic tape in the above specified color. Do not cover cable identification markings. Adjust tape locations to prevent covering of markings.

3.5 METAL CLAD WIRING INSTALLATION:

A. The location of system components, including cable routing shown on the plans, are approximate. Use good judgment in their placement to eliminate all interference with ducts, piping, etc.

B. All cable routing shall be done in a neat and workmanlike manner, consistent with recognized good practice and in accordance with the manufacturer's instructions.

C. Route the cables along the grid system. Do not route cables diagonally or in any way which restricts removal of lay-in ceiling material.

D. Support cable on ceiling wires adjacent to each luminaire and at four foot intervals using clamp supports manufactured specifically for that purpose.

END OF SECTION 260519

SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.2 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product data for ground rods, connectors and connection materials, and grounding fittings.

C. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rings, location of system grounding electrode connection, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

1.3 QUALITY ASSURANCE:

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.

C. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Burndy Corporation
2. Cadweld Div.; Erico Products Inc.
3. Ideal Industries
4. OZ Gedney Div.
5. Thermoweld
6. Thomas and Betts Corp.

2.2 GROUNDING AND BONDING PRODUCTS:

A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

B. Conductor Materials: Copper.

2.3 WIRE AND CABLE CONDUCTORS:

A. General: Comply with Division 26 Section on Wires and Cables. Conform to NEC, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductor: Green insulated.

C. Grounding Electrode Conductor: Stranded cable.

D. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B-3
2. Assembly of Stranded Conductors: ASTM B-8
3. Tinned Conductors: ASTM B-33

2.4 MISCELLANEOUS CONDUCTORS:

A. Ground Bus: Bare annealed copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.5 CONNECTOR PRODUCTS:

A. General: Listed and labeled as grounding connectors for the materials used.

B. Pressure Connectors: High-conductivity-plated units.

C. Bolted Clamps: Heavy-duty units listed for the application.

D. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

2.6 GROUNDING ELECTRODES:

A. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.

1. Size: ¾” by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATION:

A. Equipment Grounding Conductor Application: Comply with NEC for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.

1. Install separate insulated equipment grounding conductors with circuit conductors for the following in addition to those locations where required by Code:

a. Feeders and branch circuits.
b. Provide individual grounding and neutral conductors for each isolated ground receptacle. When individual or groups of isolated ground receptacles are on dedicated circuits, individual ground and neutral conductors for each circuit is acceptable.

2. Busway Circuits: Install separate insulated equipment ground conductor from the ground bus in the switchgear, switchboard, or distribution panel to the equipment ground bar terminal on the busway.
3. Laboratory Panel Circuits: Install separate insulated equipment ground wire in branch circuits from laboratory area power panels.
4. Nonmetallic Raceways: Install an insulated equipment ground conductor in nonmetallic raceways unless they are designated for telephone or data cables.
5. Air Duct Equipment Circuits: Install an insulated equipment grounding conductor to duct-mounted electrical devices operating at 120-V and above including air cleaners and heaters. Bond the conductor to each such unit.
6. Water Heater, Heat Tracing, and Anti-Frost Heater Circuits: Install separate insulated equipment ground conductor to each electric water heater, heat tracing, and surface anti-frost heating cable. Bond this conductor to heater units, piping, and connected equipment and components.

B. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicated.

C. Signal and Communications: For telephone, alarm, and communication systems, provide a #6 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal cabinet or central equipment location.

D. All systems shall be grounded in accordance with the NEC.

3.2 INSTALLATION:

A. General: Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

B. Electrical Room Ground Bus: Size, location, and arrangement as indicated. Space 1 inch from wall and support from wall 6 inches above finished floor, except as otherwise indicated.

C. Ground Rods: Locate a minimum of two-rod lengths from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors buried at least 24 inches below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without

damaging the copper coating or exposing the steel. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated.

D. Metallic Water Service Pipe:

1. Provide insulated copper ground conductors, sized as indicated, in conduit from the building main service equipment, or the ground bus, to main metallic water service entrances to the building. Connect ground conductors to the main metallic water service pipes by means of ground clamps. Where a dielectric main water fitting is installed, connect the ground conductor to the street side of the fitting. Do not install a grounding jumper around dielectric fittings. Provide grounded bushing at conduit ends and bond the ground conductor conduit to the ground bars at each end.
2. Where more than one metallic water service exists, provide insulated copper ground conductors sized to match the water service bonding jumper, in conduit, to the main service equipment main ground bus or to the other water service entrance. Provide grounded bushing at conduit ends and bond to ground bars at grounding conductor termination.

E. Braided-Type Bonding Jumpers: Install to connect ground clamps on water meter piping to bypass water meters electrically. Use elsewhere for flexible bonding and grounding connections.

F. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

G. UFER Ground: Fabricate grounding electrode conductor by installing lengthwise in form for foundation or footings. Install so conductor is within 2 inches of the bottom of the concrete. Extend conductor below grade and connect to building grounding grid, grounding electrode, or ground bar as required and as shown on plan drawings and details.

H. Labeling: Provide a phenolic tag for all grounding electrode conductors as described in section on Electrical Identification.

I. Where grounding conductors, grounding electrode conductors, or bonding conductors are non-exposed, identify each with a 6-inch band of green tape at each end and at 10 foot intervals. When run in conduits, provide color banding on conduit per section on Electrical Identification.

3.3 CONNECTIONS:

A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. 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 assure high conductivity and make contact points closer in order of galvanic series.
2. Make connections with clean bare metal at points of contact.
3. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

B. Exothermic Welded Connections: Use for connections to structural steel and for underground connections except those at test wells. Install at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors. Terminate each conductor on an individual ground lug terminal.

D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A.

E. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

F. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING:

A. Pad Mounted Gear: Install a ¾ inch by 10 feet. Driven ground rod inside the cable access block-out of the pad and set the rod depth such that 4 inches will extend above the finished pad. Where necessary, install ground rod before the equipment is placed. Protect ground rods passing through concrete with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below the concrete.

B. Grounding System: Ground non-current-carrying metallic items associated with pad-mounted equipment by connecting them to grounding electrodes arranged as indicated.

3.5 FIELD QUALITY CONTROL:

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

B. Ground Resistance Test:

1. Grounding electrode resistance testing shall be accomplished with a ground resistance direct-reading single test meter utilizing the fall-of-potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the ground electrode to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet deep.

C. Tests for patient-care areas: In addition to the test listed above, perform additional field tests and inspections for patient care areas.

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Perform Tests and Prepare certified test reports in compliance with NFPA 99 and Division 26 “Wiring Devices”. Submit reports.

D. Correct Deficiencies, Retest and Report:

1. Correct unsatisfactory conditions and retest to demonstrate compliance; replace conductors, units and rods as required to bring system into compliance.
2. Prepare a written report and show temperature, humidity and condition of soil at time of tests. Report shall be certified by testing agency that identifies components checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.6 CLEANING AND ADJUSTING:

A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where 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 Work to their original condition. Include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Restore vegetation and disturbed paving to original condition.

END OF SECTION 26 05 26

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product data for each type of product specified.

1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.

C. Shop drawings indicating details of fabricated products and materials.

D. Engineered Design consisting of details and engineering analysis for supports for the following items:

1. Suspended transformers
2. Cable trays
3. Trapeze hangers for multiple conduit runs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Slotted Metal Angle and U-Channel Systems:

a. Allied Tube & Conduit
b. B-Line Systems, Inc.
c. Unistrut Diversified Products

2. Conduit Sealing Bushings:

a. O-Z/Gedney
b. Cooper Industries, Inc.
c. Killark Electric Mfg. Co.
d. Madison Equipment Co.
e. Raco, Inc.
f. Spring City Electrical Mfg. Co.
g. Thomas & Betts Corp.

2.2 COATINGS:

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES:

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.
3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. U-Channel Systems: 12-gage steel channels, with 9/16 inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

E. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. One-Hole Conduit Straps: For supporting 1 inch and smaller rigid metal conduit; galvanized steel.
2. Two-Hole Conduit Straps: For supporting 1 inch and larger rigid metal conduit, galvanized steel; ¾ inch strap width; and 2-1/8 inch between center of screw holes.

2.4 FABRICATED SUPPORTING DEVICES:

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
2. EMT, IMC, or Rigid Conduit.

2.5 FIRE SEALS:

A. Material: Fire stopping material shall be asbestos free, 100 percent intumescent, have code approval under BOCA, ICBO, SSBC, NFPA 101, NFPA 70, and be capable of maintaining an effective barrier against flame and gases in compliance with the following requirements.

B. Flame Spread: 25 or less, ASTM E84

C. Fire Resistance and Hose Stream Tests: Fire stopping materials shall be rated "F" and "T" in accordance with ASTM E 814 or UL 1479. Rating periods shall conform to the following:

(F) 3 (T) 3 Time-rated floor or wall assemblies.

(F) 3 (T) 3 Openings between floor slabs and curtain wall.

D. Manufacturers: Subject to compliance with requirements, provide fire seals of the following:

1. 3M Company
2. STI
3. Tremco
4. Hilti

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Junction Box Supports: Comply with the NEC and the following requirement:

1. Use ¼” all-thread rod from structure to support junction boxes.

D. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs. safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Use #9 ceiling wire to support individual conduits up to 3/4inch with spring steel fasteners. Use of ceiling support wires is unacceptable.
5. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8 inch diameter or larger threaded steel rods for support.
6. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼ inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing. For hanger rods supporting 1-1/2 inch or larger conduits provide 3/8 inch minimum threaded steel rods with pipe hangers.
7. Space supports for raceways in accordance with NEC. When there are 4 or more 2 inch conduits in a trapeze, supports shall be spaced 5 feet O.C.

8. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
9. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.
10. Attachment of electrical supports to piping, ductwork, mechanical equipment or conduit is not allowed.

E. Conductor or Cable Supports: Comply with the NEC and the following requirements:

1. Support individual conductors or cables by separate clamps with rubber or plastic grommet, fasten using a non-metallic bolt and nut, and secure clamps to unistrut supports anchored to structure (multiple clamps may be secured to a single unistrut support). Individual conductors or cables may be served utilizing a vinyl or fiberglass clamp which shall be anchored to the structure.
2. Space supports as follows:

    a. Horizontal conductors not more than 3 feet o.c.
    b. Vertical conductors not more than 5 feet o.c.

3. Install simultaneously with installation of conductors.
4. MC Cable shall be supported by UL listed clip or clamp. Cable tie support is not acceptable.

F. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

G. In overhead spaces, support metal boxes directly from the building structure via 1/4" minimum all-thread or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box. Supporting metal boxes utilizing ceiling type wire is not acceptable.

H. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for cable installations as required. Where sleeves through floors are installed, extend above finish floor. For sleeves through fire rated-wall or floor construction, apply UL-listed fire stopping sealant in gaps between sleeves and cables in accordance with "Fire Resistant Joint Sealers" requirement of Division 7 Section "Joint Sealers." See Architectural plans for location and extent of fire rated assemblies.

I. Conduit Seals: Install seals for conduit penetrations of exterior walls below grade. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

J. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts or self-drilling masonry anchors on concrete or solid masonry, cast in inserts on precast structures, spring-tension clamps on steel. Drilling of structural steel members is prohibited. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and

machine or wood screws, where authorized by the Owner and structural engineer. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. Coordinate with the owner and structural engineer and obtain written prior approval of all work on concrete beams. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

K. Communication and Telephone Cable Supports: Use No. 9 ceiling wire to support individual or small bundles of cables run above accessible ceilings.

3.2 PERSONNEL PROTECTION:

A. Where U-channel systems, angles, brackets or other standard structural metal shapes are readily accessible and exposed to personnel, provide plastic or rubber end caps.

B. Where threaded rod supports are readily accessible and exposed to personnel, provide plastic or rubber end caps.

3.3 FIRE STOPPING LOCATIONS:

A. Preparation:

1. Coordination: Coordinate the work with other trades. Fire stopping materials at penetrations of insulated pipes and ducts can be applied after insulation is in place. If insulation is composed of combustible material, the thickness of fire stopping materials must be equivalent to that of the insulation. If the insulation is composed of non-combustible material, it may be considered as part of the penetrating item.
2. Surface Preparation: Surface Preparation to be in contact with fire stopping materials shall be free of dirt, grease, oil, loose material or other substances that may affect proper fitting or the required fire resistance.

B. Installation: Install fire stopping materials in accordance with the manufacturer's instructions.

C. Cleaning: After completion of fire stopping work in any area, equipment shall be reviewed and walls, ceilings and all other surfaces shall be cleaned of deposits of firestop materials.

D. Inspection: The architect may select and the Owner will pay an independent testing laboratory to examine fire stopped areas to ensure proper installation prior to concealing or enclosing the fire stopped areas.

END OF SECTION 26 05 29

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SECTION 26 05 33 RACEWAY AND WIREWAY FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. Extent of raceway work is indicated by drawings and schedules. Provide complete conduit systems for all conductors unless otherwise specified.

B. Types of raceways specified in this section include the following:

1. Electrical metallic tubing (EMT).
2. Flexible metal conduit.
3. Intermediate metal conduit (IMC).
4. Liquid-tight flexible metal conduit.
5. Non-metallic Conduit and Ducts.
6. Rigid metal conduit (RGC).
7. Wireways.
8. Rigid Aluminum Conduit.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.

1.3 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.

C. Shop Drawings: Submit dimensioned drawings of surface metal raceway systems showing layout of raceways and fittings, spatial relationships to associated equipment, and adjoining raceways, if any. Show connections to electrical power panels and feeders.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Rigid Metal Conduit:

a. Allied
b. Wheatland
c. Triangle
d. Western Tube & Conduit

2. Intermediate Metal Conduit (IMC):

    a. Allied
    b. Triangle
    c. Western Tube & Conduit

3. PVC Coated:

    a. Rob Roy
    b. Perma Cote
    c. OCAL
    d. Calbond

4. EMT Conduit:

    a. Allied
    b. Republic
    c. Triangle
    d. LTV
    e. Western Tube & Conduit

5. Non-Metallic Conduit:

    a. Carlon
    b. MPF
    c. Can-Tex
    d. PW

6. Steel Fittings:

    a. O/Z Gedney
    b. Raco
    c. Appleton
    d. EPT
    e. Midwest
    f. Picoma
    g. Steel City

7. Conduit Bodies:

    a. O/Z Gedney
    b. Killark
    c. Regal
    d. Appleton
    e. Crouse Hinds

8. Wireway:

    a. Square D. Co.
    b. Circle AW Products
    c. Erickson Electric Equipment Co.
    d. G.S. Metals Corp.
    e. Hoffman Engineering Co.
    f. Wadsworth Electric Mfg. Co., Inc.

2.2 METAL CONDUIT AND TUBING:

A. Rigid Galvanized Steel Conduit (RGC):

1. Conduit: Rigid steel, zinc-coated inside and outside, threaded ends.
2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.

B. Intermediate Metal Conduit (IMC):

1. Conduit: Rigid intermediate grade galvanized inside and outside, threaded ends.
2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.

C. PVC Externally Coated Rigid Steel Conduit:

1. Conduit: Rigid steel zinc-coated with external coating of PVC.
2. Fittings: Threaded galvanized steel with external PVC coating, bushings shall have nylon insulated throat.

D. Electrical Metallic Tubing (EMT):

1. Conduit: Galvanized steel tubing.
   Fittings: Steel compression fittings for rain-tight and concrete-tight applications. Steel set-screw for all other connections. Set-screw quick fit type for 2-1/2 inches and larger may be used. Bushings shall be threaded and have nylon insulated throat or nylon bushing.

E. Rigid Aluminum Conduit:

1. Not allowed unless otherwise noted.

F. Flexible Metal Conduit:

1. Conduit: Continuous spiral wound, interlocked, zinc-coated steel, approved for grounding.
2. Fittings: Zinc coated, malleable iron. Straight connector shall be one-piece body, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. Angle connectors shall be two piece body with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. All fittings shall be terminated with threaded bushings having nylon insulated throats.

G. Liquid-Tight Flexible Metal Conduit:

1. Conduit: Continuous spiral wound, interlocked zinc-coated steel with polyvinyl chloride (PVC) jacket, approved for grounding.
2. Fittings: Zinc coated malleable iron. Straight and angle connectors shall be the same as used with flexible metal conduit but shall be provided with a compression type steel ferrule and neoprene gasket sealing rings.

2.3 NON-METALLIC CONDUIT AND DUCTS:

A. Rigid Non-Metallic Conduit (RNC):

1. Conduit: Schedule 40 or 80 polyvinyl chloride (PVC), 90°C for direct burial or concrete encasement.
2. Fittings: Mate and match conduit type and material. Cement as recommended by manufacturer.

B. PVC and ABS Plastic Utilities Duct:

1. Conduit: Type 2 (EB) for encased burial in concrete; Type II (DB) for direct burial.
2. Fittings: Mate and match conduit type and material. Cement as recommended by manufacturer.

2.4 CONDUIT BODIES:

A. General: Types, shapes and sizes, as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

B. Metallic Conduit and Tubing: Use malleable iron conduit bodies. Use bodies with threaded hubs for threaded raceways and in hazardous locations.

C. Nonmetallic Conduit: Use nonmetallic conduit bodies.

2.5 WIREWAYS:

A. General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service as indicated. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other components and accessories as required for complete system.

B. Lay-In Wireways: Construct lay-in wireways with hinged covers in accordance with UL 870 with components UL listed. Construct units to be capable of sealing cover in closed position with sealing wire.

1. Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached so that removal is not necessary to utilize the lay-in feature.
2. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

C. Rain-tight Troughs: Construct in accordance with UL 870, with components UL listed.

1. Construction: 16-gauge galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14 gauge parts for 8" x 8" and larger sections. Provide knockouts only in bottom of troughs, with suitable adapters to facilitate attaching to other NEMA 3R enclosures. Do not use Gasketing that can rip or tear during installation, or would compromise rain-tight capability of the trough. Do not use cover screws that will protrude into the trough area and damage wire insulation.
2. Finish: Provide 14-gauge and 16-gauge galvanized sheet metal parts with corrosion-resistant phosphate primer and baked enamel finish. Plate hardware to prevent corrosion.

2.6 CONDUIT SIZES:

A. Conduit sizes shall be as shown on the drawings. If the conduit size is not given on the drawings, the conduit shall be sized in accordance with NEC based on the number of

conductors enclosed plus a parity sized equipment ground conductor and be subject to the following minimum sizes:

1. Rigid, Intermediate, and EMT Conduit: ¾" for all runs except lighting switch legs, 277 volt lighting branch circuits, temperature control and fire alarm which may be 1/2inch.
2. Flexible and Liquid-Tight Flexible Conduit: ½" for all runs.
3. MC Cable: 3/8" to under-counter luminaires, ½" for all other runs.
4. Underground or Concrete Encased Nonmetallic Conduit: ¾" for all runs.
5. Conduits used for home runs shall contain only the conductors for the circuits indicated on the drawings. Combining multiple home runs into a single conduit will not be permitted.

2.7 RACEWAY SEALING COMPOUND:

A. Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 deg. F (1 deg. C), withstands temperature of 300 deg. F (149 deg. C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials and the common metals.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Provide notification in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 CONDUIT SCHEDULE:

A. Buried Raceways: rigid PVC plastic conduit.

B. Raceways embedded in concrete slabs or walls in contact with earth: coated rigid steel galvanized conduit.

C. Raceways embedded in concrete slabs above grade level: Schedule 40 plastic conduit in slab.

D. Raceways Through Foundation Walls Below Grade: One 10 foot section of PVC coated rigid steel galvanized, extending from 1 foot inside the foundation wall.

E. Hazardous areas: Rigid steel galvanized conduit.

F. Raceways in locations subject to mechanical injury: Rigid steel galvanized conduit or intermediate metal conduit. Locations subject to mechanical injury include, but are not limited to, the following:

1. Exposed conduits outdoors up to 8' A.F.G.
2. Exposed conduits in dock areas and high/medium bay locations up to 25 feet above finished floor.
3. Exposed conduits in parking garages.
4. Exposed conduits in a Fire Pump Room.
5. Exposed service entrance feeders.

G. Motor and equipment connections: PVC jacketed liquid-tight flexible metallic conduit with liquid tight connectors.

H. Raceways in all other areas shall be electrical metallic tubing unless otherwise noted.

I. Use flexible metal conduit inside movable partition wireways, from junction boxes to devices and between devices in casework, from outlet boxes to recessed luminaires, and for "fishing" of existing walls.

J. Emergency Electrical System Circuits: All emergency and Essential Electrical system circuits shall be run totally in non-flexible metal conduit.

K. Rework or extensions of existing conduit shall include the use of similar materials to the existing conduit type unless otherwise noted.

3.3 INSTALLATION OF CONDUITS:

A. General: Install electrical raceways in accordance with manufacturer's written installation instruction, applicable requirements of NEC, and as follows:

1. Conceal all conduits unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
2. Elevation of Raceway:

    a. Where horizontal raceway is installed near water and steam piping, route raceway above piping and as close to structure as possible and practical.
    b. Route raceway as close to structure as possible.

3. Complete installation of electrical raceways before starting installation of conductors within raceways.
4. Provide supports for raceways as specified elsewhere in Division 26.
5. Prevent foreign matter from entering raceways by using temporary closure protection.
6. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bend is not visible above the finished slab.
7. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
8. Use raceway fittings that are types compatible with the associated raceway and suitable for the use and location. Install expansion fittings across all structural construction joints and expansion/deflection couplings across all structural expansion joints.
9. Run raceways parallel and perpendicular to building elements and other equipment with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
10. Raceways embedded in slabs: (Allowed only by written authorization of Structural Engineer/Architect): Install with a minimum of bends, in the shortest practical distance, in middle third of the slab thickness where practical, and leave at least 1 inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run conduit larger than 1inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit is used, raceways must be converted to PVC coated rigid steel conduit before rising above floor.
11. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

12. Install vertical feeder conduits in exterior walls, core walls, or chase spaces. Do not install in interior wall partition areas.
13. Run exposed and parallel raceways together. Make bends in parallel runs from the same center line so that the bends are parallel. Factory elbows may be used only where they can be installed parallel. In other cases provide field bends for parallel raceways.
14. Make raceway joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Joints in non-metallic conduits shall be made with solvent cement in strict accordance with manufacturer's recommendations.
15. Tighten set screws of thread less fittings with suitable tool.
16. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. RGC and IMC shall be secured with double locknuts and an insulated metallic bushing. EMT shall be secured with one locknut and shall have nylon insulated throats or threaded nylon bushings from 1/2" to 1". 1-1/4" and above shall be metal with nylon insulated throats. Use grounding type bushings for feeder conduits at switchboards, panelboards, pull boxes, transformers, motor control centers, VFD's, etc.
17. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
18. Provide nylon pull string with printed footage indicators having not less than 200 pounds tensile strength. Leave not less than 12 inches of slack at each end of the pull string. Identify with tags at each end the origin and destination of each empty conduit and indicate same on all empty or spare conduits on the as-built drawings.
19. Telephone and Signal System Raceways: Install raceways with maximum lengths at 100 feet and with a maximum of two, 90 degrees radiused bends or equivalent. Install 2' x 2' pull boxes where necessary to comply with these requirements. Install long sweep bends for all data and voice raceways.
20. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, 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 and elsewhere as indicated:

    a. Where conduits enter or leave hazardous locations.
    b. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
    c. Where conduits enter through a foundation wall or stub-up through a slab on grade floor.
    d. Where required by the NEC.

21. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded plugs flush with floor.
22. Flexible Connections: Use short length (maximum of 6 feet) of flexible conduit for recessed and semi-recessed luminaires, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate ground conductor across flexible connections. Where PVC conduit/couplings have been approved for exterior use and are exposed to sunlight,

provide UV rated PVC coatings or protect with 2 coats of water based latex paint that is chemically compatible with the PVC products. Color selection shall be by Architect.

23. PVC externally coated rigid steel conduit: Patch all nicks and scrapes in PVC coating after installing conduit.
24. Where conduits are to be installed through structural framing members, the Contractor shall provide sleeves. The Architect/Engineer's written approval must be obtained prior to cutting, notching or drilling of structural framing members.
25. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.
26. Use of running threads for rigid or intermediate metallic conduit are not permitted. When threaded couplings cannot be used, provide 3 piece union or solid coupling.
27. Route conduit through roof openings for piping and ductwork where possible; otherwise, rout through jack with pitch pocket.
28. Conduit stub-ups from below grade or thru the slab shall be PVC coated or PVC taped rigid steel galvanized conduit and shall extend 6 inches above grade.
29. Wherever conduits enter a structure through a foundation or basement wall below grade, grout around the conduit with water-proof grout or install entrance seals. Seals shall be OZ Type WS or approved equivalent for new construction and OZ type CSM Series for existing structures.
30. Conduits shall not cross pipe shafts or ventilation duct openings. Where conduits must penetrate air-tight spaces or plenums, seal around the conduit with a mastic acceptable to the Architect/Engineer.
31. Install an insulated ground conductor in all conduits.
32. Where individual conduits penetrate existing fire-rated walls and floors, pack void around conduit with fire rated insulation and seal opening around conduit with UL listed foamed silicone elastomer compound. Where conduits penetrate exterior walls, new floors, or roof, provide pipe sleeve one size larger than conduit, pack void around conduit with fire rated insulation, and seal opening around conduit with UL listed foam silicone elastomer compound.
33. Where conduit sleeves penetrate fire rated floors or walls for installation of system cables, AC or MC cables, or modular wiring cables pack void around cables or empty sleeve with fire rated insulation and fill ends with fire-resistive compound. Seal opening around sleeve with UL listed foam silicone elastomer compound.
34. Use PVC-coated rigid steel or Fiberglass factory elbows for bends in plastic conduit runs longer than 100 feet, or in plastic conduit runs which have more than two bends regardless of length. Use long sweep bends for wiring larger than 350 mcm.
35. Wipe plastic conduit clean and dry before joining. Apply full even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.
36. No PVC conduit shall be run exposed or inside stud or masonry walls unless specifically called for on the drawings. Transition from PVC to metal conduit shall be made below grade.
37. Provide separate raceway systems for each of the following:

    a. Lighting
    b. Power Distribution
    c. Communications and Data
    d. Emergency Systems

        a) Lighting
        b) Power Distribution

    e. Fire Alarm
    f. Temperature Control

38. Paint new exposed conduits to match existing exposed conduits where installed in areas with existing painted conduits or where otherwise indicated.

39. Provide rebar and tie downs for all conduits and conduit racks to be installed with concrete or slurry to prevent conduit “float”.

B. Install buried electrical line warnings per Division 26 section - “Electrical identification”.

C. Install labeling as required in Division 26 section - “Electrical Identification”.

3.4 INSTALLATION OF WIREWAYS:

A. Wireways: Mechanically assemble metal enclosures and raceways to form continuous electrical conductor and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.

1. Where practicable, avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
2. Install expansion fittings in all raceways wherever structural expansion joints are crossed.
3. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. Field bends of raceway sections are not permitted.
4. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported.
5. Use boxes as supplied by raceway manufacturer wherever junction, pull or device boxes are required. Standard electrical "handy" boxes, etc., are not permitted for use with surface raceway installations.
6. Install an insulated grounding conductor in all wireways and surface raceways. Bond grounding conductor to all wireways and surface raceways.
7. Paint new exposed surface metal raceway to match adjacent surfaces where raceway is installed in finished areas such as lobbies, corridors, and normally occupied spaces.
8. Surface raceways and wireways are acceptable only where specifically indicated on the drawings. The proposed use of surface raceways and wireways shall be submitted for review by the Engineer prior to installation.
9. Common wireways are not acceptable for convergence of multiple circuits unless specifically indicated on the drawings. The proposed use of a common wireway shall be submitted for review by the Engineer prior to installation.
10. The proposed use of wireways above or below panelboards, switchboards, motor control centers, and other electrical equipment shall be submitted along with a layout drawing for review by the Engineer prior to installation.

3.5 ADJUSTING AND CLEANING:

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt and construction debris.

END OF SECTION 26 05 33

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SECTION 26 05 34 CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY:

A. This section includes cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other sections. Types of products specified in this section include:

1. Outlet and device boxes
2. Pull and junction boxes
3. Floor boxes and service fittings
4. Cabinets
5. Hinged door enclosures
6. Boxes and fittings for hazardous locations

B. Conduit-body-type electrical enclosures and wiring fittings are specified in the Division 26 Section on Raceways.

1.2 DEFINITIONS:

A. Cabinets: An enclosure designed either for surface or for flush mounting and having a frame, or trim in which a door or doors may be mounted.

B. Device Box: An outlet box designed to house a receptacle device or a wiring box designed to house a switch.

C. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.

D. Hinged Door Enclosure: An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box.

E. Outlet Box: A wiring enclosure where current is taken from a wiring system to supply utilization equipment.

F. Wiring Box: An enclosure designed to provide access to wiring systems or for the mounting of indicating devices or switches for controlling electrical circuits.

1.3 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Submit product data for cabinets and enclosures with classification higher than NEMA 1.

C. Shop drawings for floor boxes and boxes, enclosures, and cabinets that are to be shop fabricated (non-stock items). For shop fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Floor Boxes:

a. American Electric.
b. Butler Mfg. Co.
c. Cooper Industries, Inc.
d. Raco, Inc.
e. Thomas & Betts Corp.

2. Cabinets:

a. Hoffman Engineering Co.
b. Erickson Electrical Equipment Co.
c. Electric Panelboard, Inc.
d. Parker Electrical Mfg. Co.
e. Spring City Electrical Mfg. Co.
f. Square D Co.
g. Circle AW

3. Boxes and Fittings for Hazardous Locations:

a. OZ/Gedney.
b. Cooper Industries, Inc.
c. Killark Electric Mfg. Co.
d. Adalet-PLM.
e. Robroy Industries, Inc.
f. Spring City Electrical Mfg. Co.
g. Appleton

2.2 CABINETS, BOXES, AND FITTINGS, GENERAL:

A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers including blank covers for unused boxes, knockout closures for unused openings and other accessories required for the intended use. Provide gaskets for units in damp or wet locations. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

2.3 MATERIALS AND FINISHES:

A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.

B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.

C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.

D. Cast Metal for Boxes, Enclosures, and Covers; Copper-free aluminum except as otherwise specified.

E. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.

F. Painted Interior Finish: Where indicated, white baked enamel. Emergency system cabinets and boxes shall be red.

G. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connecters.

2.4 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES:

A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application. For multiple device installations, use multi-gang boxes. Sectional boxes are not permitted. Provide barrier for different voltage conductors in the same box.

B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be 4” square minimum with 2” depth minimum sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior/plaster rings and fixture studs.

C. Cast-Aluminum Boxes: Copper free aluminum deep type, with threaded raceway entries/hubs, and features and accessories suitable for each location including mounting ears, threaded screw holes for devices and closure plugs.

D. Malleable or Cast-Iron Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.

E. Malleable or Cast-Iron Floor Boxes: Fully adjustable, waterproof, with threaded raceway entrances, adjusting rings, gaskets, and brass floor plates. Where indicated, provide multi-section boxes with individual hinged section covers. Provide for power, data, and communication outlets as indicated on the drawings.

2.5 NONMETALLIC OUTLET, DEVICE, AND SMALL WIRING BOXES:

A. General: Conform to NEMA OS 2, "Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports" and UL 514C, "Nonmetallic Outlet Boxes, Flush Device Boxes and Covers." Boxes shall be molded PVC units of type, shape, size, and depth to suit location and application.

B. Boxes for Concealed Work: Mounting provisions and wiring entrances to suit installation conditions and wiring method used.

C. Boxes for Exposed Work: Ultra-violet stabilized, nonconductive, high impact-resistant boxes with integrally molded raceway entrance hubs and removable mounting flanges. Boxes shall be equipped with threaded screw holes for device and cover plate mounting. Each box shall have a molded cover of matching PVC material suitable for the application.

2.6 PULL AND JUNCTION BOXES:

A. General: Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.

B. Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing.

C. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.

D. Stainless-Steel Boxes: Fabricate of stainless steel conforming to Type 302 of ASTM A 167, "Specification for Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip." Where necessary to provide a rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.

E. Cast-Aluminum Boxes: Molded of copper free aluminum, with gasketed cover and integral threaded conduit entrances and Neoprene gaskets.

F. Malleable or Cast-Iron Boxes: Molded of iron alloy with gasketed cover and integral threaded conduit entrances.

G. Boxes Approved for Classified Locations: Cast metal boxes conforming to UL 886, "Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations," listed and labeled for use in the specific location classification, and with the specific hazardous material encountered. Conduit entrances shall be integral threaded type.

2.7 CABINETS:

A. Comply with UL 50, "Electrical Cabinets and Boxes."

B. Construction: Sheet steel, NEMA 1 class except as otherwise indicated. Cabinet shall consist of a box and a front consisting of a one piece frame and a hinged door. Arrange door to close against a rabbet placed all around the inside edge of the frame, with a uniformly close fit between door and frame. Provide concealed fasteners, not over 24 inches apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24 inches apart and not over 6 inches from top and bottom of door. For flush cabinets, make the front approximately ¾” larger than the box all around. For surface mounted cabinets make front same height and width as box.

C. Doors: Double doors for cabinets wider than 24 inches.

D. Telephone cabinets wider than 48 inches may have sliding or removable doors. Provide ¾” thick plywood backboard painted matte white for Television, telephone and other communication cabinets.

E. Locks: Combination spring catch and key lock, with all locks for cabinets of the same system keyed alike. Locks may be omitted on signal, power, and lighting cabinets located within wire closets and mechanical-electrical rooms. Locks shall be of a type to permit doors to latch closed without locking.

2.8 STEEL ENCLOSURES WITH HINGED DOORS:

A. Comply with UL 50, "Cabinets and Enclosures" and NEMA ICS 6, "Enclosures for Industrial Controls and Systems."

B. Construction: Sheet steel, 16 gage, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface mounting.

C. Doors: Hinged directly to cabinet and removable, with approximately ¾ inch flange around all edges, shaped to cover edge of box. Provide handle operated, key locking latch. Individual door width shall be no greater than 24 inches. Provide multiple doors where required.

D. Mounting Panel: Provide painted removable internal mounting panel for component installation.

E. Enclosure: NEMA 1 except as indicated. Where door gasketing is required, provide neoprene gasket attached with oil-resistant adhesive, and held in place with steel retaining strips. For all enclosures of class higher than NEMA 1, use hubbed raceway entrances.

2.9 CAST METAL ENCLOSURES WITH HINGED DOORS:

A. Copper free aluminum with bolted, hinged doors. Where used at hazardous (classified) locations, enclosures shall conform to UL and shall be listed and labeled for the classification of hazard involved.

2.10 MOLDED NONMETALLIC ENCLOSURES WITH HINGED DOOR:

A. General: Molded, glass fiber reinforced high impact strength polyester with bolt or screw secured doors and solid neoprene gaskets.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

A. Locations: Install items where indicated and where required to suit code requirements and installation conditions. Coordinate box locations with Architectural elements including casework, backsplash, door swings, etc.

B. Cap with Knock out closures all unused knockout holes where blanks have been removed and plug unused conduit hubs.

C. Support and fasten items securely in accordance with Division 26 Section on Supporting Devices.

D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated. Size boxes to accommodate wire pulling, splices, taps, equipment connections and code compliance.

E. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 APPLICATIONS:

A. Cabinets: Flush mounted, NEMA enclosure type 1 except as otherwise indicated.

B. Hinged Door Enclosures Indoor: NEMA type 1 enclosure except as indicated.

C. Hinged Door Enclosures Outdoors: NEMA Type 4. Install drip hood, factory tailored to individual units.

D. Hinged Door Enclosures in Corrosive Locations: NEMA type 4X nonmetallic enclosure.

E. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:

1. **Interior Dry Locations: Sheet steel, NEMA Type 1.**
2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.
3. Wet Locations: NEMA Type 4 enclosures.
4. Corrosive Locations: NEMA Type 4X enclosures.
5. Hazardous (Classified) Locations: NEMA type listed and labeled for the location and class of hazard indicated.

F. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.

G. Floor Boxes: In slabs on grade and wet locations use NEMA type 4 boxes. At other locations in slabs, use concrete-tight NEMA 1 boxes.

3.3 INSTALLATION OF OUTLET BOXES:

A. Outlets at Windows and Doors: Locate close to window trim. For outlets indicated above doors center outlets above the door opening except as otherwise indicated.

B. Column and Pilaster Locations: Locate outlet boxes for switches and receptacles on columns or pilasters so the centers of the columns are clear for future installation of partitions.

C. Locations in Special Finish Materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides. Install such boxes without plaster rings. Saw cut all recesses for outlet boxes in exposed masonry walls.

D. Gasketed Boxes: At the following locations use malleable or cast metal, threaded hub type boxes with gasketed weatherproof covers:

1. Exterior locations.
2. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations).
3. Where exposed to moisture laden atmosphere.
4. At food preparation equipment within four ft. of steam connections.
5. High traffic areas (surface installations).
6. Where indicated.

E. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles vertically, except above counter receptacles to be mounted horizontally. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side. Provide far side box supports, for electrical switch boxes installed on metal studs and provide stud to stud support for electrical receptacle boxes installed on metal studs.

F. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4 inches square by 1-1/2 inches deep, minimum.

G. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.

H. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.

I. Concrete Boxes: Use extra deep boxes to permit side conduit entrance without interfering with reinforcing, but do not use such boxes with over 6 inch depth.

J. Floor Boxes: Install in concrete floor slabs so they are completely enveloped in concrete except for the top. Where normal slab thickness will not envelop box as specified above, provide increased thickness of the slab. Provide each compartment of each floor box with grounding terminal consisting of a washer-in-head machine screw, not smaller than no. 10-32, screwed into a tapped hole in the box. Adjust covers of floor boxes flush with finished floor.

K. Back to back outlet boxes are not permitted. Separate boxes a minimum of 6 inches in standard walls and 24 inches in acoustical walls.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES:

A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8 inches square by 4 inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed the following:

Size of Largest Conductors in Box	Maximum no. of Conductors in Box
No. 4/0 AWG	30
250 MCM	20
500 MCM	15
Over 500 MCM	10

B. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 inches inside boxes.

C. Mount pull boxes in inaccessible ceilings with the covers flush with the finished ceiling. Where possible, locate pull and junction boxes above accessible ceilings in finished areas.

D. Flush in grade outdoor boxes shall be adequately supported against settling or tipping. Where heavy traffic or poor soil compaction exists, cast box in concrete base which provides 6” of cover around and under the box.

E. Size: Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.5 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES:

A. Mount with fronts straight and plumb.

B. Install with tops 78 inches above floor.

C. Set cabinets in finished spaces flush with walls.

3.6 GROUNDING:

A. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.

3.7 CLEANING AND FINISH REPAIR:

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.

B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.

C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION 26 05 34

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes underground conduits and ducts, duct banks, pull boxes and hand-holes, manholes and other underground utility structures.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 2 Section "Earthwork" for general requirements for excavation, backfill and related items for ducts, manholes and hand-holes.
2. Division 3 Section "Cast-In-Place Concrete" for cast-in-place concrete requirements.
3. Division 7 Section "Sheet Membrane Waterproofing" for waterproofing of manholes and hand-holes.
4. Division 7 Section "Bituminous Damp-proofing" for damp-proofing of manholes and hand-holes.

C. Provide pulling eyes, cable stanchions, cable arms, and insulators as required.

1. For each manhole/hand-hole, furnish 1 stanchion for each 30 linear inches (750 mm) of interior floor perimeter. In addition, furnish 1 arm for each stanchion, 3 insulators for each arm, and a total of 3 pulling eyes. Furnish materials complete with associated fasteners, packaged with protective covering for storage and with identification labels clearly describing contents.

1.2 DEFINITIONS:

A. Duct: Electrical conduit and other raceway, either metallic or nonmetallic, used underground, embedded in earth or concrete.

B. Duct Bank: 2 or more conduits or other raceway installed underground in the same trench or concrete envelope.

C. Hand-hole: An underground junction box in a duct or duct bank.

1.3 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product data for metal accessories for manholes and hand-holes, conduit and duct, duct bank materials, and miscellaneous components.

C. Shop drawings showing details and design calculations for precast manholes and hand-holes, including reinforcing steel. Stamp drawings with seal of registered professional structural engineer.

D. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.

E. Inspection report for factory inspections, according to ASTM C 1037.

F. Coordination drawings showing duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to accurate scale.

G. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architect and Owner, and other information specified.

H. Field test reports indicating and interpreting test results relative to compliance with performance requirements of "Field Quality Control" Article in Part 3 of this Section.

I. Record Documents: Show dimensioned locations of underground ducts, hand-holes and manholes.

1.4 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Firm experienced in manufacturing underground precast concrete utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a record of successful in-service performance.

B. Comply with NFPA 70 "National Electrical Code" and ANSI C2 "National Electrical Safety Code" for components and installation.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

D. Coordinate layout and installation of ducts, manholes, and hand-holes with final arrangement of other utilities as determined in the field.

E. Coordinate elevations of duct and duct bank entrances into manholes and hand-holes 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 ensure duct runs drain to manholes and hand-holes, and as approved by the Architect.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping and deforming.

B. Store precast concrete units at 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.

1.6 EXTRA MATERIALS:

A. Furnish extra materials matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.

B. Furnish cable stanchions, support arms, insulators, and associated fasteners each in quantities equal to 5 percent of quantities installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Frames and Covers:

a. Campbell Foundry Co.
b. East Jordan Iron Works, Inc.
c. McKinley Iron Works, Inc.
d. Neenah Foundry Co.

2. Nonmetallic Ducts:

a. Arnco Corp.
b. Breeze-Illinois, Inc.
c. CANTEX, Inc.
d. Carlon; Lamson & Sessions Company.
e. Pipe and Plastic Group; Certainteed Products Corp.
f. Cole-Flex Corp.
g. Electri-Flex Co.
h. Spiraduct, Inc.

2.2 CONDUIT AND DUCT:

A. Rigid Steel Conduit: ANSI C80.1, galvanized.

B. Plastic-Coated Rigid Steel Conduit and Fittings: NEMA RN 1.

C. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, rated for use with 90 deg C conductors under all installation conditions.

D. PVC Conduit and Tubing Fittings: NEMA TC 3.

E. Rigid Plastic Underground Conduit: UL 651A, Type A PVC.

F. Rigid Plastic Underground Conduit: UL 651A, Type EB PVC.

G. Rigid Plastic Underground Conduit: High-density polyethylene, Schedule 40.

H. Rigid Plastic Underground Conduit: Fiberglass-reinforced epoxy.

2.3 PULL BOXES AND HANDHOLES:

A. Cast metal Boxes: Cast aluminum, sized as indicated, with outside flanges and recessed, gasketed cover for flush mounting. Nonskid finish on cover.

B. Fiberglass Hand-holes: Molded fiberglass, sized as indicated, with 6-inch square (150 mm) cable entrance at each side, weatherproof cover with nonskid finish.

C. Cover Legend: ELECTRIC.

2.4 ACCESSORIES:

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting.

B. Frames and Covers: Cast iron with cast-in legend ELECTRIC or SIGNAL as appropriate. Machine cover-to-frame bearing surfaces.

C. Cable Support Insulators: High glaze, wet-process porcelain arranged for mounting on cable arms.

D. Ground Rods: Solid copper clad steel, 3/4 inch (18 mm) diameter by 10-feet (3 m) length.

E. Ground Wire: Stranded bare copper, No. 6 AWG minimum.

F. Raceway Sealing Compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 degrees F (1 degrees C), withstands temperature of 300 degrees F (149 degrees C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

PART 3 - EXECUTION

3.1 APPLICATION:

A. Underground Ducts For Electrical Utility Service: Plastic conduit encased in concrete.

B. Underground Ducts For Electrical Feeders: Direct buried plastic conduit.

C. Underground Ducts For Electrical Branch Circuits: Flexible corrugated conduit encased in concrete.

D. Underground Ducts For Telephone Utility Service: Plastic utilities duct encased in concrete.

E. Underground Ducts For Communication Circuits: Plastic underground conduit encased in concrete.

3.2 EXAMINATION:

A. Examine site to receive ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 EARTHWORK:

A. Excavation and Backfill: Conform to Division 2 Section "Earthwork," but do not use heavy-duty, hydraulic-operated compaction equipment.

B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform according to Division 2 Section "Landscape Work."

C. Warning Tape: Tape specifically manufactured for marking and locating underground utilities. Tape shall be polyethylene film, 6 inches wide, 0.004 inches thick and a minimum strength of 1,750 psi. Tape shall carry continuous inscription naming the specific utility. Color shall be:

1. Electric - Red
2. Phone and Data Cable - Orange

Tape for nonmetallic utility lines shall have foil backing or wires sufficient for detection by metal detector to a depth of 3 feet. Tape to be run continuously from manhole to manhole and have 3 feet slack rolled up at each end.

D. Restore disturbed paving. Refer to "Cutting and Patching" in Division 1.

3.4 CONDUIT AND DUCT INSTALLATION:

A. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.

B. Slope: Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain toward manholes and hand-holes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions.

C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends. Use only factory fittings for elbows, bends or offsets. Field bending is not permitted. Risers to grade to be PVC coated steel elbows.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Duct entrances to Hand-holes: Space end bells approximately 10 inches (250 mm) on center for 5-inch (125 mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

F. Building Entrances: Transition from underground duct to conduit 10 feet (3 m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below.

1. Concrete-Encased Ducts: Install reinforcing 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 Duct Entering Non-waterproofed Walls: Install a Schedule 40 galvanized-steel pipe sleeve for each duct. Caulk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.
3. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

G. Separation Between Direct-Buried, Non-encased Ducts: 3 Inches (75 mm) minimum for like services, and 6 inches (150 mm) minimum between power and signal ducts.

H. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting. 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 use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (18 mm) reinforcing rod dowels extending 18 inches (450 mm) into the concrete on both sides of joint near the corners of the envelope.
3. Reinforcing: Reinforce duct banks where they cross disturbed earth and where indicated.
4. Forms: Use the walls of the trench to form the side walls of the duct bank where the 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: Except as otherwise indicated, install top of duct bank at least 24 inches (600 mm) below finished grade in non-traffic areas and at least 30 inches (750 mm) below finished grade in vehicular traffic areas.

I. Stub-Ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5 m) from edge of pad. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches (75 mm) of concrete.

J. Sealing: Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi (1.03 MPa) hydrostatic pressure.

1. Provide nylon pull string with printed footage indicators having not less than 200 pounds tensile strength. Leave not less than 12 inches of slack at each end of the pull string. Identify with tags at each end the origin and destination of each empty conduit and indicate same on all empty or spare conduits on the as-built drawings.

K. Pulling Cord: Install 100-pound-test nylon cord in ducts, including spares.

L. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, 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 and elsewhere as indicated:

1. Where conduits enter or leave hazardous locations.
2. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
3. Where conduits enter through a foundation wall or stub-up through a slab on grade floor.
4. Where required by the NEC.

M. Install raceway/duct sealing compound inside of all underground raceways that stub into a building through a foundation wall or through a slab on grade floor.

3.5 FIELD QUALITY CONTROL:

A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.

1. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
2. Duct Integrity: Rod ducts with a ball type mandrel ¼" (6 mm) smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest. The Contractor shall notify prior to commencing integrity testing to request observation of procedures.
3. Water Tightness: Make internal inspection of manholes 3 months after completion of construction for indications of water ingress. Where leakage is noted, remove water and seal leak sources. Re-inspect after 2 months and reseal remaining leak sources. Repeat process at 2 month intervals until leaks are corrected.

B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.6 CLEANING:

A. Pull brush through full lengths of ducts. Use round bristle brush with a diameter ½" (12 mm) greater than internal diameter of duct.

END OF SECTION 26 05 43

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SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:

1. Buried electrical line warnings.
2. Identification labeling for raceways, cables, and conductors.
3. Operational instruction signs.
4. Warning and caution signs.
5. Equipment labels and signs.

B. Identification required in this section shall apply to equipment furnished in Division 26 and any other applicable Divisions including Division 23.

1.2 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product Data for each type of product specified.

C. Submit schedule of identification nomenclature to be used for identification signs and labels for each piece of equipment including, but not be limited to, the following equipment types as specified in Division 26.

1. Cabinets and enclosures
2. Switchboards and Switchgear
3. Panelboards
4. Disconnect switches
5. Circuit breakers and switches
6. Motor control centers
7. Starters
8. Variable frequency drives
9. Transfer switches
10. Engine generators and all ancillary cabinets and equipment
11. Fire alarm system panels and all ancillary cabinets and equipment
12. Nurse call system panels and all ancillary cabinets and equipment
13. Paging, intercom and background music system cabinets.
14. Lighting control cabinets including dimmer cabinets.

D. Submit samples of each color, lettering style and other graphic representation required for identification materials including samples of labels and signs.

1.3 QUALITY ASSURANCE:

A. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Ideal Industries, Inc.
2. LEM Products, Inc.
3. Markal Corp.
4. Panduit Corp.
5. W.H.Brady, Co.
6. 3M Company

2.2 ELECTRICAL IDENTIFICATION PRODUCTS:

A. Adhesive Marking Labels for Exposed Raceway and Busway: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Emergency, Lighting, Power, Power D.C., HVAC, Communications, Control, Fire).

1. Label Size for Raceways and Busway: Kroy or Brother Labels 1 inch high by 12 inches long (minimum) with 5/8 inch minimum height letters.
2. Normal: White letters on black background indicating source equipment designation, circuit number(s), and voltage.
3. Emergency: Indicate source equipment designation, circuit number(s), and voltage for each applicable system/branch as follows.

    a. Standby: Black letters on OSHA Orange

4. Fire Alarm: White letters on red background indicating "FIRE ALARM".
5. Temperature Control: White or black letters on blue background indicating "TEMP. CONTROL."
6. Ground: White or black letters on green background indicating "GROUND" and equipment and designation.
7. Building Alarms: Orange letters on white background indicating "BUILDING ALARMS."
8. Network Fiber: Black letters on white background indicating "NETWORK FIBER."
9. Where conduits enter or exit a panelboard, pull or junction box, switchboard, or other distribution equipment, conduit labels shall include circuit number in addition to feeder identification and voltage.

B. Provide colored Adhesive Marking Tape for banding Wires and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width. Make each color band completely encircling cables, at penetrations of walls and floors, at each junction box and at 20-foot maximum intervals in straight runs.

C. Underground Line Marking Tape: Metal-detector detectable, permanent, bright-colored, continuous-printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

E. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Engraved legend in white letters on black face for normal and

white letters on red face for emergency, black letters on yellow face for UPS and punched for mechanical fasteners. Where required for ground connections, provide engraved legend in white letters on green face.

F. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws when screw ends do not protrude into working areas of equipment otherwise use number 10/32 stainless steel machine screws with nuts and flat and lock washers or rivets.

G. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50 lb minimum tensile strength, and suitable for a temperature range from minus 50 degrees F to 350 degrees F. Provide ties in specified colors when used for color coding.

H. Adhesive Marking Tape for Device Cover Plates: 3/8 inch Kroy tape or Brother labels with 3/16 inch minimum height letters. Tape shall have black letters on clear background for normal and red letters on clear background for emergency. Embossed Dymo-Tape labels are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code. Clean surfaces to receive nameplates and labels and install nameplates and labels on front of equipment parallel with equipment/raceway/cable/wire/etc. lines.

B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

D. Conduit Identification:

1. Adhesive Marking Labels: Provide adhesive marking labels for exposed raceway and busway and Raceway or Busway located above accessible ceilings. Install labels at **//30** foot intervals. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible. Labels for multiple conduits shall be aligned and read the same direction.

E. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system voltage and identity of contained circuits on outside of box cover. Color code shall be same as raceway systems. Use self-adhesive marking tape labels at exposed locations and indelible black marker at concealed boxes.

F. Underground Electrical Line Identification: During trench backfilling, for exterior underground power, signal and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker. Tape shall be 6 inches wide, 0.004 inches thick and 1750 psi minimum strength, trace wire run continuous length manhole to manhole and to equipment. Provide 3 feet slack rolled at each end.

1. Install line marker for underground wiring, both direct-buried and in raceway. Red for electrical, orange for phone and cable.

G. Circuit Identification: Tag or label conductors as follows:

1. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
2. Multiple Circuits: Where multiple branch circuits, control wiring or communications/signal conductors are terminated or spliced in a box or enclosure, label each conductor or cable with circuit number. For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

H. Apply warning, caution and instruction signs and stencils as follows:

1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8 inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

    a. Provide sign at main service entrance switch, indicating type and location of on-site stand-by generator as required by NEC. Sign shall read “Secondary Source Provided by Engine Generator Located In Room NAME and NUMBER”.

I. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.

    a. Panelboards, electrical cabinets and enclosures.
    b. Access doors and panels for concealed electrical items.
    c. Electrical switchboards.
    d. Motor starters.
    e. Pushbutton stations.
    f. Power transfer equipment.
    g. Contactors.
    h. Remote-controlled switches.
    i. Dimmers.
    j. Control devices.
    k. Power generating units.
    l. Telephone switching equipment.

m. Clock/program master equipment.
n. Call system master station.
o. TV/audio monitoring master station.
p. Fire alarm master station or control panel.
q. Security monitoring master station or control panel.

J. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.

K. For panelboards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.

L. Tag all grounding electrode conductors, associated bonding conductors, and grounding conductors at their point of attachment to any ground bus and grounding electrode (where possible) with a 2 inch diameter round green phenolic nameplate. Lettering shall be 1/4 inch high with 1/5 inch between lines centered on the tag stating "DO NOT DISCONNECT," "MAIN GROUND." Nameplate shall attach to conductor with a short length of small chain.

M. Install labels at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

N. Provide adhesive marking tape labels for identification of individual receptacles including receptacles in furniture systems and light switch wall-plates. Locate tape on front of plate and identify panel and branch circuit serving the receptacle. Provide tape labels for identification of individual switches or thermal overload switches which serve as equipment disconnects. Locate the tape on the front of the cover-plate and identify panel and branch circuit serving the equipment.

END OF SECTION 26 05 53

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SECTION 26 05 83 – WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY:

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

B. Applications of electrical power connections specified in this section include the following:

1. To resistive heaters.
2. From electrical source to motor starters.
3. From motor starters/motor controllers/VFD’s/etc. to motors.
4. To lighting equipment.
5. To converters, rectifiers, transformers, inverters, rheostats, and similar current adjustment features of equipment.
6. To grounds including earthing connections.
7. To master units of communication, signal, alarm, clock, public address, sound, and video systems.
8. From push buttons to equipment requiring electrical connection.
9. Other connections as shown.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.

1.3 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials. All mechanical and plumbing equipment shall be coordinated with unit nameplate information per the actual nameplate to be included on the equipment. As a minimum, information shall include: Operating Voltage; MCA (Min. circuit amperes); FLA (Full load amperes); MFS (Max. fuse size) or MOP (Max. overcurrent protection); and SCCR (Short Circuit Current Rating) and shall match electrical equipment and protection/distribution sizes and be rated for available short circuit currents as shown on the drawings. Bracing for equipment shall be provided at incoming terminals and as an option throughout the equipment for the available fault current or downstream equipment and devices shall be protected by current limiting fuses.

1.4 DEFINITIONS:

A. Load voltage wiring shall be defined as:

1. Conduit and wiring required to carry power to motors and other equipment or devices. Wiring from control devices to equipment that carry power to drive that equipment such as line voltage thermostats, etc., shall be included as load voltage wiring. Wiring that provides power to control panels, control transformers, control relays, time clocks, etc., shall also be included as load voltage wiring.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Deliver electrical connection products wrapped in proper factory fabricated type containers.

B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.

C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide circuit and motor disconnects by one of the following:

1. General Electric Co.
2. Eaton
3. Square D Company
4. Siemens Energy & Automation, Inc.
5. Westinghouse Electric Corp.

2.2 GENERAL:

A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated. Comply with Division 26 Section on Low Voltage Circuit Protective Devices, with OCPDs adapted to equipment connection installation. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.

B. Provide motor controllers that are horsepower rated to suit the motor controlled.

C. Contacts shall open each ungrounded connection to the motor. Contacts shall be NEMA rated, 75 degrees C.

D. Overload relays shall be ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full load current of the specific motor to which connected with appropriate adjustment for duty cycle and power factor correction supplied with the motor.

2.3 MATERIALS AND COMPONENTS:

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, disconnect, starter, contactor, relays, etc., and other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings:

1. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Provide products complying with Division-26 section on Raceways.

C. Wires, Cables, and Connectors:

1. General: Provide wires, cables, and connectors complying with Division-26 section on Wires and Cables.
2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes, ratings, and material of wires/cables which are supplying electrical power.
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wire-nuts and cable ties as recommended for use by accessories manufacturers for type services indicated.
5. Cord and Plug Connected Equipment: Where indicated, contractors shall provide a length of SO cord complete with a straight blade or twist-lock receptacle for connection of equipment. Cord and plug rating shall be suitable for the connected equipment load and rating of the branch circuit overcurrent protective device. Plug shall match receptacle configuration included on the plans and cord length shall be as required. Contractor shall connect cord to equipment.

2.4 MANUAL MOTOR STARTERS:

A. Manual starters shall be flush-mounting type except where conduits are run exposed or as otherwise noted. Manual starters shall be complete with properly sized overload protection and neon pilot light. Manual starters shall be Square D Class 2510 or Allen-Bradley Bulletin 600 with stainless steel plates. Handles shall be lockable in open and closed position without modification.

B. Heater units in all manual motor starters shall be sized for approximately 115 percent of full load motor current. Check and coordinate all thermal protective devices with the equipment they protect.

2.5 CIRCUIT AND MOTOR DISCONNECT SWITCHES:

A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features, ratings, and enclosures as indicated. All equipment with maximum fuse size listed in nameplate shall have fusible disconnect switch provided. Provide NEMA 1 enclosure. For outdoor switches and switches indicated as weatherproof, provide NEMA 3R enclosures with rain-tight hubs. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads.

B. Fusible Switches: Provide UL type "HD" 100 percent duty rated switches, with fuses of classes and current ratings indicated. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses. All disconnect switches shall be fusible unless otherwise noted.

C. Non-fusible Disconnects: Provide UL type "HD" 100 percent duty rated switches of classes and current ratings as indicated.

D. Double-Throw Switches: Provide heavy duty switches of classes and current ratings as indicated.

E. Switches for Classified (Hazardous) Locations: Provide heavy duty switches, with UL labels and listings for hazardous location classifications in which installed.

F. Accessories:

1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated or required.
2. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:

   a. Stainless Steel Type 304: For NEMA Type 4.
   b. Molded Fiberglass Reinforced Plastic: For NEMA Type 4x.
   c. Heavy Cast Aluminum: For hazardous locations. NEMA Types 7 through 9.

3. Handles shall be lockable in open and closed position without modification.
4. Disconnect switches provided in the motor feeders between a VFD and the motor shall be provided with auxiliary contacts at the disconnect that de-energizes power to the VFD.

2.6 MOTOR STARTERS:

A. See Division 23 for Requirements

2.7 AUXILIARY CONTROL DEVICES:

1. Built in 120 volts control circuit transformer, fused from line side, where service exceeds 120 volts.
2. Ammeters, Voltmeters, and Frequency Meters: Panel type, 2-1/2 inch minimum size with 90 degree or 120 degree scale and plus or minus 2 percent accuracy. Where indicated. Current Sensors: Rated to suit application.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. Furnish, set in place, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, plumbing and fire protection, elevator, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match

conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Maintain existing electrical service and feeders to equipment serving occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

E. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

F. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torqueing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torqueing requirements are not available, tighten connectors and terminals to comply with torqueing values contained in UL's 486A.

I. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.

J. Provide suitable strain relief clamps for cord connection to outlet boxes and equipment connection boxes.

K. Make wiring connections in control panel or in wiring compartment of pre-wired equipment and interconnecting wiring in accordance with manufacturer's instructions.

L. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated or per manufacturer's instructions.

M. Provide each motor with a fused disconnect switch for 3 phase motors and horsepower rated and/or thermal rated disconnect switch for single phase motors as shown on schedules or required. Coordinate with manufacturers of standalone, packaged and other equipment for factory installed and field installed motors and controllers.

N. Provide circuit and motor disconnect switches as indicated and where required by Code. Comply with switch manufacturers printed installation instructions. Install within sight of motors.

O. All splices in control panels, terminal junction boxes, low voltage control circuits and fire alarm conductors shall be on numbered terminal strip.

P. Each branch circuit serving dedicated, isolated or emergency receptacles, multi-outlet assemblies or equipment connections shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit shall only be permitted where specifically noted.

Q. Where conduit is not required, plenum rated cable shall be provided in ceiling, floor or other air plenum spaces.

R. Provide 4" concrete housekeeping pads for new motor control sections and all floor mounted equipment.

3.3 FIELD QUALITY CONTROL:

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

3.4 EQUIPMENT CONNECTION SCHEDULES:

A. Mechanical Equipment:

1. Refer to Mechanical Equipment Schedule on the drawings.
2. It is suggested that all load voltage wiring shall be provided under Division 26.
3. Unless otherwise indicated, it is suggested that all equipment motors and control shall be furnished, set in place, and wired in accordance with the schedule contained herein. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent of this schedule is to have the Contractor responsible for coordinating all wiring as outlined, whether or not specifically called for by the Division 23 or Division 26 drawings and specifications. Comply with the applicable requirements of Division 26 for all electrical work which is not otherwise specified. No extras will be allowed for contractor's failure to provide for these required items. Contractor shall refer to the Division 26 and Division 23 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

ITEM	FURNISHED BY	SET BY	CONTROL WIRING (non-load voltage)
1. Mechanical Equipment Motors	M	M	--
2. Special Equipment (i.e., elevators, etc.)			
a. Motors	G	G	--
b. Magnetic Motor Starters	G	E*	--
c. Disconnect Switches	E	E	--
d. Thermal OL Switches			
e. Manual Operating Switches			
3. Motor Starters, combination motor starter/disconnect and Variable Frequency Drives			
a. Automatically controlled, with or without HOA switches.	M	E*	M
b. Manually controlled.	M	E*	--
c. Starters integral with motor control center including control relays and transformers.	E	E	--
d. Combination Starter/Disconnects	M	E*	M
4. Pushbutton stations, pilot lights	M	E*	M

ITEM	FURNISHED BY	SET BY	CONTROL WIRING (non-load voltage)
5. Disconnect switches, thermal overload switches, manual operating switches.	E	E*	M
6. Multi-speed switches	M	E*	M
7. Control relays, transformers.	M	M	M
8. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
9. Non-load voltage control items.	M	M	M
10. Electric thermostats, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of mechanical equipment or directly attached to ducts, pipes, etc.	M	M	M
11. Motor valves, damper motor, solenoid valves, EP and PE switches, VAV box controls, actuators, etc.	M	M	M**
12. Control circuit outlets	E	E	--
a. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
b. Non-load voltage control items.	M	M	M
c. Electric thermostats, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of mechanical equipment or directly attached to ducts, pipes, etc.	M	M	M
d. Motor valves, damper motor, solenoid valves, EP and PE switches, VAV box controls, actuators, etc.	M	M	M**
e. Control circuit outlets	E	E	--
13. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
14. Non-load voltage control items.	M	M	M
15. Electric thermostats, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of mechanical equipment or directly attached to ducts, pipes, etc.	M	M	M
16. Motor valves, damper motor, solenoid valves, EP and PE switches, VAV box controls, actuators, etc.	M	M	M**
17. Control circuit outlets	E	E	--
18. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
19. Non-load voltage control items.	M	M	M
20. Fire protection controls (Including flow switches)	M	M	M**

ITEM	FURNISHED BY	SET BY	CONTROL WIRING (non-load voltage)
21. Duct smoke detectors, including relays for fan shutdown.	E	M	M**
22. Temperature Control Panel	M	M	M
23. Interlocks	M	M	M

G = General, Division 13 or 14
M = Mechanical, Division 23
E = Electrical, Division 26

* For factory pre-wired equipment specified under other Divisions, all wiring within the equipment shall be by the manufacturer. All required field wiring between sections or other field connection details for power and/or control shall be clearly identified on shop drawings for contractor installation. Division 26 drawings show the provided electrical characteristics for equipment.

Manufacturer's equipment provided under other divisions which varies from what is shown on Division 26 drawings shall be the responsibility of the Contractor to complete and pay for any costs for those variations.

** Fire alarm system control modules and wiring from fire alarm contacts to fire alarm system shall be installed by Fire Alarm system installer and match other components of the system. Refer to Division 28. See details.

*** Integral control wiring under Electrical Division as manufacturer supplied equipment. Control wiring for automatic control portion under Mechanical Division.

END OF SECTION 26 05 83

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

A. Extent of lighting control equipment work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, programmable controllers, data equipment, relays, switches, control wiring, and ancillary equipment.

B. Types of lighting control equipment specified in this section include the following:

1. Digital Programmable Lighting Controls
2. Occupancy Sensors
3. Manual Modular Dimming Systems
4. Time controlled switches
5. Emergency Shunt Relays
6. Photoelectric Relays

C. Refer to other Division-26 sections for wires/cables, electrical boxes and fittings and wiring devices which are required in conjunction with lighting control equipment work.

1.2 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Shop Drawings: Submit layout drawings of lighting control equipment and components including, but not necessarily limited to, programmable controllers, manual override switches and stations, occupancy/vacancy sensors, dimmers, dimmer system components, daylight sensors, transceivers, printers, relays and other switches and equipment. Drawings shall show locations and associated addresses of all devices and equipment. In addition, show spatial relationship of lighting control equipment to other electrical equipment in proximity. List and verify that design sequence of operation and programmability including initial sensor/programed on/off times, override control settings, etc., have been provided for each lighting control zone.

C. Submit lists of Driver and LED combinations compatible with dimmer systems, by manufacturer and catalog number.

D. Wiring Diagrams: Submit wiring diagrams for lighting control equipment and components showing control and interconnection wiring, include connections to equipment components and electrical power feeders. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed. Provide a voltage drop calculation for network cabling to verify EOL voltage compliance.

E. Coordination Drawings: Submit evidence that lighting controls and devices are compatible with connected monitoring and control devices. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

F. Agreement to Maintain: Prior to time of final acceptance, the Installer shall submit an agreement for continued service and maintenance of lighting control equipment, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued

testing and servicing, including replacement of materials and equipment, for one year period with option for renewal of Agreement by Owner.

G. Maintenance Manuals: Ensure manual includes operating instructions in addition to instructions for maintenance of the system's software package.

H. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

I. Commissioning Report: Submit Preliminary and Final Commissioning Report for all Lighting Control Equipment. Preliminary report shall be submitted no later than 90 days of the date of receipt of the certificate of occupancy. Reports shall be organized and include information as required by the current edition of the IECC-International Energy Conservation Code.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types, ratings and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with lighting control equipment work similar to that required for this project.

C. Agreement to Maintain: Engage Installer who is willing to execute with the Owner, required agreement for continued maintenance of lighting control equipment.

D. FCC Compliance: Comply with Part 68 of Federal Communications Commission Rules pertaining to telephone equipment registration by manufacturer.

1. Provide telephone equipment with FCC labels indicating applicable FCC registration and numbering of equipment.

E. Codes and Standards:

1. Energy Code Compliance: Meet the requirements of the current edition of the IECC-International Energy Conservation Code. In addition, meet any additional requirements of the Local AHJ-Authority Having Jurisdiction.
2. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction, installation of lighting control and communications equipment.
3. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems, Article 725 and manufacturer specification.
4. UL Compliance: Comply with applicable requirements of UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide lighting control equipment and components which are UL-listed and labeled. Lighting control panels shall be UL 916 and UL 924 Listed.
5. NEMA Compliance: Comply with applicable requirements of NEMA's Std. Pub No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)."
6. EIA Compliance: Comply with applicable requirements of Electronic Industries Association standards pertaining to telephone and electronic systems.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Deliver lighting control equipment and components in factory-fabricated type containers or wrappings, which properly protect equipment from damage.

B. Store lighting control equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle lighting control equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.5 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. Electrically Held Relays: Equal to 5% of amount installed.
2. Occupancy/Vacancy Sensors: Equal to 5% of the amount installed for each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide lighting control equipment of one of the following (for each type and rating of equipment):

1. Digital programmable lighting controls:

a. Lighting Control & Design, Inc.
b. Wattstopper (The)
c. Sensor Switch
d. Encelium
e. Douglas
f. Leviton

2. Occupancy/Vacancy Sensors:

a. Sensor Switch
b. Leviton
c. Lutron
d. Hubbell
e. WattStopper (The)

3. Manual Modular Dimming Systems:

a. Lutron
b. Crestron
c. Leviton

4. Time Controlled Switches:

a. WattStopper (The)

b. Leviton
c. Lutron
d. Hubbell

5. Automatic Load Control Relays (ALCR) and Emergency Shunt Relays (ESR):

a. WattStopper (The)
b. LVS

2.2 DIGITAL PROGRAMMABLE LIGHTING CONTROLS:

A. General: Provide factory-fabricated lighting control equipment and ancillary components of sizes, types, ratings and electrical characteristics indicated; consisting of programmable controllers, data equipment, relays, switches, control wiring, interfaces to dimming systems, and interfaces to building management systems which comply with manufacturer's standard design, materials and components; and construct in accordance with published product information for duty indicated, and as required for a complete installation.

B. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

C. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

D. Programmable Lighting Controller Description: Programmable, unit with graphic display and programming of system status and to override relay status; and to display status of local override controls and diagnostic information.

1. Interoperability:

a. Controller shall be configured to connect to a BACnet-compliant network, resulting in extending control to any network-compliant devices such as occupancy/vacancy switches.
b. Mechanical Controls Interface: Where indicated, occupancy sensors within a control zone shall send occupied state or unoccupied state information to BAS, associated Network, or individual room equipment as identified by Mechanical Controls Contractor.

1) Provide all necessary interface components to allow the lighting control system and BAS/Network/Equipment to seamlessly communicate.

c. A/V System Interface: Where indicated, provide the necessary interface components and programming to allow override of the lighting control system by the A/V system within the specified control zone. The full operability of the lighting under normal conditions shall be maintained including dimming, switching, and color-changing.

1) All lighting within indicated control zone shall maintain required emergency operation while under A/V system override.

2) Contractor shall coordinate the communications protocol with the A/V system supplier and shall provide the necessary hardware and programming for a fully operation system.

2. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
3. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
4. Automatic Time Adjustment: System shall synchronize to real time through internet protocol, shall automatically adjust for leap year with manual time and date of adjustment selection, shall automatically adjust for daylight saving time with manual ON/OFF for this feature, and shall provide Time Controls utilizing 7 Day clock with minimum 7 different day times per week, and programmable auto Holiday “shutoff”.
5. Astronomic Control: Automatic adjustment of dawn and dusk switching based on exterior photoelectric sensor control.
6. Automatic battery backup shall provide power to maintain program and system clock operation for 3 days' minimum duration when power is off.
7. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.
8. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.
9. Automatic Control: System capable of activating building areas into user dictated pattern of ON-OFF array of relays, according to either weekly schedule divided into one-minute increments, or two one-day schedules.
10. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override. Utilize “Flick Warning” where indicated.
11. Manual Controls: System capable of activating each lighting zone or single groups of relays ON-OFF with a momentary switch; Provide prioritization of manual controls.
12. Manual Lockout: System capable of selecting, activating and locking-in any lighting pattern from central controller, and locking-out manual and automatic commands.

E. Manual Switches and Plates

1. Switches: Provide momentary toggle type ON-OFF switches with spring return to center position; and as recommended by lighting systems manufacturer for services indicated. An integral pilot light shall indicate the status of circuit.
2. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

F. Relays: Provide relays for control of inductive loads of 20 amperes at 120-volts, 50 to 60 Hz, as recommended by lighting systems manufacturer for services indicated.

2.3 OCCUPANCY/VACANCY SENSORS:

A. Wall or ceiling-mounting, solid-state units with a separate relay unit.

1. Passive Infrared, Ultrasonic, Microphonic, or Dual Technology. Provide Dual Technology Devices unless otherwise shown. Spacing and coverage per the manufacturer’s recommendations.

2. 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 30 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
4. Relay Unit: Dry contacts rated for 20-A ballast/driver load at 120- and 277-V ac.
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.

2.4 MANUAL MODULAR DIMMING SYSTEMS:

1. Factory-fabricated equipment providing 1 to 4 channels of manual dimming control as indicated. Common on-off switching and components into a 2- or 3-gang wall box under a single flush wall plate.
2. System to be listed for control of the type of lighting unit used.
3. Fluorescent dimmers to control lights smoothly over a range of 100 percent to 10 percent of full brightness.
4. Unit to be rated at 1900 watts, minimum with each dimming channel rated 600 watts, minimum.

2.5 TIME CONTROLLED SWITCHES:

A. Provide solid state programmable unit with alphanumeric display capable of periodically and automatically switching indoor and outdoor lamps both ON and OFF. Select switches with 7 Day clock which permits selection of at least 7 ON-OFF operations each day and allows timing durations of 1 to 24 hours; with ratings of 125-volts, 60 Hz, and with SPST switch of 40-amperes per pole. Provide indoor-outdoor mount enclosure, NEMA Type 3, with side hinged door and lock, mounting holes and knockouts; construct enclosure of 0.036" drawn steel. Provide timing switch with manual circuit by-pass switch and separate grounding terminal. Finish enclosure with manufacturer's standard gray finish.

2.6 AUTOMATIC LOAD CONTROL RELAYS (ALCR)/ EMERGENCY SHUNT RELAY UNITS (ESR):

A. Self-contained ALCR/ESR units shall comply with and be listed under UL 924.

1. Operation: Normally-closed electrically-held relay to be wired in parallel with control switch/relay. Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Unless otherwise indicated ALCR/ESR shall control as follows:

   a. Emergency luminaires shown in rooms with other switched luminaires (Not indicated “NL” (night light) and/or connected to an always on emergency circuit) provide ALCR/ESR to allow indicated control of all luminaires in space. Provide room controller or other devices necessary to accommodate dimming and other control equipment and requirements. Emergency lights in space shall be brought to full brightness from emergency circuit whenever the normal circuit serving the room loses voltage. Sensing from panelboard feeders is not acceptable; sensing shall be accomplished at the branch circuit level. Normal lighting and controls shall be restored automatically when normal power is available.
   b. Egress lighting shall meet requirements of NFPA 101.

2. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

3. LED Indicator Light: Indicates status of normal and emergency power.

2.7 PHOTOELECTRIC SENSORS:

A. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photo-resistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Light-Level Monitoring Range: 10 to 1000 fc with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with dead-band adjustment.

B. Outdoor Photoelectric Switch: Solid-state, light-level sensor unit to detect changes in lighting levels that are perceived by the eye.

1. Light-Level Monitoring Range: 1.5 to 10 fc with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 30 second minimum to prevent cycling, with dead-band adjustment.
3. Surge Protection: Metal-oxide varistor, complying with IEEE requirements for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.8 WIRELESS EQUIPMENT:

A. Wireless equipment and equipment containing batteries shall only be allowed where specifically shown or indicated.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which lighting control equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

A. Install lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices.

B. Low voltage control wiring terminations shall be made within electrical boxes.

C. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.

D. Interconnect lighting control equipment with building management system, after lighting equipment installation work has been completed and is operating properly. Define groups in the lighting control system to interface with the building management system as indicated on the temperature control matrix.

E. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A and B.

F. Co-locate equipment as much as practical for ease of maintenance.

G. Provide hardwired connections to each device, controller, sensor, etc. for control connections.

3.3 GROUNDING:

A. Provide equipment grounding connections for lighting control equipment as indicated. Tighten connectors to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL:

A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Testing and retesting at no cost to Owner.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust all field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing with commissioning report.

C. Perform the following field tests and inspections for each piece of equipment and each device and prepare test reports:

1. Test for circuit continuity.
2. Verify that the control module features are operational.
3. Check operation of local override controls.
4. Test system diagnostics by simulating improper operation of several components selected by facilities.

D. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values and submit settings list with Testing and Equipment Settings Report. Provide current licenses for software in O&M manuals.

E. Commissioning Report: Provide Commissioning services required to provide Preliminary and Final Commissioning Report for all Lighting Control Equipment. Preliminary report shall be submitted no later than 90 days of the date of receipt of the certificate of occupancy. Testing and Reports shall be organized and include information as required by the current edition of the IECC.

F. Testing and training shall be provided at times scheduled with the owner and may need to be done off hours.

3.5 PERSONNEL TRAINING:

A. Manufacturer's Field Service indicated above shall include Owner’s maintenance personnel.

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

C. Provide extra scheduled time with owner to make corrections to the system to meet the functionality/time control requirements desired by the owner. Record any changes in the Testing and Equipment Settings Report and submit final documents.

END OF SECTION 26 09 23

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SECTION 26 24 13 – SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes low-voltage power service and distribution switchboards and associated auxiliary equipment rated 600 V or less.

1.2 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product data for each product and component specified.

C. Shop drawings for each switchboard including dimensioned plans and elevations, component and device lists, and a single-line diagram showing main and branch bus current ratings and continuous and short-circuit ratings of switchboard.

D. Shop drawings or other descriptive documentation of optional barriers specified for electrical insulation and isolation. Show front and side views of enclosures with dimensions; conduit entrance locations and requirements; nameplate legends, size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation; voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components, including fuses and breakers provided.

E. Shop drawings of utility company metering provisions with indication of approval by utility company.

F. Shop drawings of spare fuse cabinet showing material, dimensions, and features including storage provisions for fuse cartons.

G. Schedule of features, characteristics, ratings, and factory settings of individual protective devices.

H. Manufacturer's Schematic Wiring Diagram.

I. Point-to-Point Control Wiring Diagram: Differentiating between manufacturer-installed and field-installed wiring (may be submitted upon delivery of switchboard).

J. Mimic bus diagram: Submit updated version of diagram reflecting field changes after final switchboard load connections have been made.

K. Maintenance Data: Submit operation and maintenance data, schedule of recommended service and parts lists for materials and products. Include this data, product data, shop drawings, record drawings, and wiring diagrams in maintenance manual in accordance with requirements of applicable Division 26 Sections and Division 1.

1.3 QUALITY ASSURANCE:

A. Listing and Labeling: Provide switchboard assemblies that are listed and labeled.

1. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.

B. Product Selection for Restricted Space: The Drawings indicate maximum dimensions for switchboard equipment including clearances between switchboard and adjacent surfaces and items. Switchboards having equal performance characteristics and complying with indicated maximum dimensions may be considered.

C. Manufacturer's Qualifications: Firms regularly engaged in the manufacture of switchboards, of types, sizes and capacities required, and whose products have been in satisfactory use in similar service for not less than 5 years.

D. Installer's Qualifications: Firm with at least 5 years of successful installation experience on project utilizing switchboard units similar to that required for this project.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Deliver switchboards and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated handling of heavy items. Utilize factory-fabricated type containers or wrapping for switchboards and components which protect equipment from damage. Inspect equipment to ensure that no damage has occurred during shipment.

B. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

C. Store switchboard equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping. Store so condensation will not occur on or in switchboards. Provide temporary heaters as required to assure avoiding condensation.

D. Handle switchboard equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.5 EXTRA MATERIALS:

A. Spare Indicating Lamps: Furnish 6 of each type and color installed.

B. Touch-Up Paint: Furnish 3 half-pint containers.

1.6 SEQUENCING AND SCHEDULING:

A. Schedule delivery of switchboard equipment which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.

B. Coordinate the size and location of concrete equipment pads.

C. Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring, as necessary to interface installation of switchboards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. General Electric Co.
2. Square D Co.
3. Siemens Energy & Automation, Inc.
4. Eaton

B. Metering Equipment:

1. General Electric
2. Square D Co.
3. Siemens Energy & Automation, Inc.
4. ABB Power Distribution, Inc.
5. Eaton
6. Sangamo
7. TESCO

2.2 SWITCHBOARDS, GENERAL:

A. Description: Front-connected, front-accessible, with fixed, individually mounted main device, panel-mounted branches, and sections rear aligned. Dead front, metal enclosed, self-supporting and conforming to NEMA PB2.

B. Barriers: Between adjacent switchboard sections.

2.3 FABRICATION AND FEATURES:

A. Enclosure: Steel. NEMA 1.

B. Enclosure Finish for Indoor Units: Manufacture standard gray finish over a rust inhibiting primer on phosphatizing treated metal surface. Provide painted surfaces that conform to IEEE C37.20.1, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear."

C. Utility Metering Compartment: Fabricated compartment and section meeting utility company requirements. Where separate vertical section is required for utility metering, match and align with basic switchboard.

1. Provide integral meter base in accordance with utility standards.

D. Bus Transition and Incoming Line Pull Sections: Where required, match and align with basic switchboard. Line terminations shall be accessible from the front of the switchboard.

E. Hinged Front Panels: Provide to allow access to breaker, metering, accessory, and blank compartments.

F. Pull Box on Top of Switchboard: Provide where indicated or where required by installation conditions, and include the following features:

1. Adequate ventilation to maintain air temperature in pull box within same limits as switchboard.

G. Buses and Connections: Three-phase, four-wire except as otherwise indicated. Features as follows:

1. Phase and Neutral Bus Material: Hard-drawn copper, 98 percent conductivity with copper feeder circuit-breaker line connections. Where specifically shown on the drawings provide 1350 Aluminum, 61% conductivity with aluminum/copper feeder circuit-breaker line connections. Horizontal cross busses throughout shall be non-tapered – 100 percent rated. Size bus in accordance with NEMA PB2.
2. Contact Surfaces of Buses: Tin plated for copper bus, Tin or copper plated for aluminum bus.
3. Main Phase Buses, Neutral Bus, and Equipment Ground Bus: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from either end by means of bolt holes or other approved method and connecting links.
4. Neutral Buses: 100 percent of the ampacity of the phase buses except as indicated.
5. Ground Bus: 1/4 inch by 2 inch minimum size, hard-drawn copper of 98 percent conductivity
6. Provide two bolt CU/AL Mechanical Lugs for all incoming and outgoing feeders including neutral and ground connections.
7. Provide for any outgoing or incoming bus or cabling as required for each breaker space (i.e. all spares, spaces, and utilized).

H. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents. Busses shall be bolted with access for future torque maintenance.

I. Provide four (4) spare two-hole CU/AL lugs for #2 AWG through #4/0 AWG conductors on load side of main circuit breakers.

J. Provide lugs on load side of distribution device (breakers, switches, etc.), including neutral and ground lugs, as shown on the drawings and as necessary to meet or exceed capacity of OCPD.

K. Provide internal bussing to output lugs or bus flange for each spare breaker provided. All spare cells shall be wired complete to match other cells being utilized. Provide output lugs or bus flange for each spare. Provide lugs unless flange is specifically noted.

L. Barriers: Provide between adjacent switchboard sections.

2.4 OVERCURRENT PROTECTIVE DEVICES (OCPDS):

A. Comply with requirements of Division 26 Section on Overcurrent Protective Devices for types of OCPDs indicated. Provide indicated features, ratings, characteristics, and settings.

B. Future Devices: Where provision for future overcurrent protective devices or space is indicated, equip compartments with mounting brackets, supports, bus connections, and necessary appurtenances, designed for the OCPD types and ampere ratings indicated for future installation of devices.

2.5 OTHER CIRCUIT CONTROL AND PROTECTIVE DEVICES:

A. General: Factory-installed and -tested devices of types listed below, with indicated ratings, settings, and features.

B. Control Power: Where electrically operated/ shunt tripped circuit breakers/or other control power functions are required, provide 120 volt control circuits supplied through secondary disconnect devices from a control power transformer. Include the following features:

1. Control Power Transformers: Dry type. Separate compartments for units larger than 3 KVA and their fuses.
2. Provide two control power transformers in separate compartments with necessary interlocking relays. Connect the primary of each control power transformer at the line side of the associated main circuit breaker. Connect the 120 volt secondary's through a relay or relays as a control bus.
3. Control Power Fuses: Include primary and secondary fuses for current-limiting and overload protection.
4. Provide control power disconnecting means on line side of transformer.
5. Provide control fuse status indication on front and contacts for remote alarm.

C. Control Wiring: Factory installed, complete with bundling, lacing, and protection, and complying with the following:

1. Flexible Conductors: Use for size No. 8 and smaller and for conductors across hinges, and conductors for interconnections between shipping units.
2. Conductors Sizes: In accordance with NEC for the duty required.
3. All control wiring shall be terminated on labeled power type terminal blocks with ring terminals.
4. Limit cable bundles to 12 cables maximum.

D. Surge Arresters (UL SA rated-category OWXH): Provide distribution class, metal oxide Varistor as specified in IEEE C62.11, "Standards for Metal-Oxide Surge Arresters for AC Power Circuits," or IEEE C62.1 "Gapped Silicon-Carbide Surge Arresters for Alternating Current Power Circuits." Install in the service entrance cable termination compartment and connect in each phase of each incoming circuit. Coordinate rating with circuit voltage.

1. Description: Coordinate impulse spark-over voltage with system circuit voltage, and provide factory mounting and connection.

E. SPD: Provide surge protective device for switchboards where required and/or indicated on the drawings. Refer to Division 26 Section - "Surge Protective Device" for requirements.

2.6 INSTRUMENTATION:

A. Provide the items specified below and mount within utility metering compartment or on front cover of associated breaker.

1. Instrument Transformers: NEMA Standard EI 21.1, "Instrument Transformers for Revenue Metering 110 kV BIL and Less," IEEE Standard C57.13, "Requirements for Instrument Transformers," and the following:

a. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
b. Current Transformers: Ratios and accuracy class suitable for connected relays, meters, and instruments.

2. Electronic Circuit Monitor: Provide multi-function digital instrumentation where indicated on the drawings which contains the following functions:

a. REAL TIME Readings:

1) Current (Per Phase, N, G, 3X)
2) Voltage (L-L, L-N)
3) Real Power (Per Phase, 3-phase)
4) Reactive Power (Per Phase, 3-phase)
5) Apparent Power (Per Phase, 3-phase)
6) Power Factor (Per Phase, 3-phase)
7) Frequency
8) THD (Current and Voltage)

3. Watt-Hour Meter: Flush or semi-flush type, rated 5 amperes, 120 V, 3 phase, 3 wire, with 3 elements, 15-minute-indicating-demand register and provision for testing and adding pulse initiation.

2.7 RATINGS:

A. Provide nominal system voltage, continuous main bus amperage, and short-circuit-current ratings as indicated on the drawings.

2.8 IDENTIFICATION:

A. General: Refer to Division 26 section on Electrical Identification. Identify units, devices, controls, and wiring with factory-applied labels and signs.

B. Compartment Nameplates: Engraved laminated plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.

C. UL nameplates shall be provided for all switchboards. Information shall include, but not be limited to, manufacturer, model number, serial number, plant or manufacturing location, ampere rating, voltage rating, wire and phase identification and bus short circuit bracing rating.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install switchboards and accessory items in accordance with manufacturers' written installation instructions and the following specifications:

B. Anchor each switchboard assembly to the leveled concrete base in accordance with manufacturer's recommendations. Attach by bolting using minimum of 3/8 inch bolts. Meet appropriate seismic zone requirements.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount printed, basic operating instructions. Include building main one line diagram for switchboards, including control and key interlocking sequences, and emergency procedures. Include building main one-line diagram. Fabricate frame and cover with clear acrylic plastic. Frame shall be open at the tope for easy removal of drawings for use and updating. Mount on the front of the switchboards.

3.2 IDENTIFICATION:

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 section on Electrical Identification.

3.3 GROUNDING:

A. Connections: As indicated. Tighten connections to comply with tightening torques specified in UL 486A and 486B.

3.4 CONNECTIONS:

A. Tighten switchboard bus joint bolts and electrical connector and terminal bolts in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not stated, use those specified in UL 486A for copper and UL 486B for aluminum.

3.5 FIELD QUALITY CONTROL:

A. General: Comply with applicable standards of the National Electrical Testing Association (NETA) including Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems."

B. Manufacturers Field Testing and Start-Up: Manufacturer shall have NETA certified technician perform the following quality control testing, visual and mechanical inspections, electrical tests, and tests of the switchboard.

1. Pretesting: Upon completing installation of the system, perform manufacturer's recommended testing, NETA testing, and the following preparations for tests:

a. Make insulation resistance tests of connecting supply, feeder and control circuits.
b. Make continuity tests of circuits.
c. Provide set of Record Documents. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
d. Provide manufacturer's instructions for installation and testing of switchboard assembly to Owner and Engineer.
e. Visual inspection of all factory and field wiring for proper live bus clearance and secured for fault currents.

2. Quality Control Testing Program: Conform to the following:

a. Test Objectives: To assure switchboard installation meets specified requirements, is operational within specified tolerances, provides appropriate protection for system and equipment, and is suitable for energizing.
b. Procedures: Make field tests and inspections and prepare switchboard assemblies for satisfactory operation in accordance with NETA Standard ATS ("Acceptance Testing Specifications for Electrical Power, Distribution Equipment and Systems") applicable IEEE standards, manufacturer's recommendations, and these specifications.
c. Schedule tests and provide notification at least one week in advance of test commencement.
d. Reports: Prepare written reports of test results and observations. Report defective materials and workmanship. Include complete records of repairs and adjustments.

e. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicated test results, date, and responsible person and organization.

f. Visual and Mechanical Inspection: Include the following inspections and related work:

1) Inspect, for defects and physical damage, testing laboratory labels and nameplate compliance with current single-line diagrams. Verify smooth and proper operation of all doors, hinges, handles, latches, etc. Correct or replace as determined necessary by the Owner/Engineer.
2) Verify that current transformers, potential transformers, and fuses meet specified requirements. Verify relays, meters, and instrumentation are checked and all connections are made properly. Introduce accurately metered currents and/or voltages to relays and other devices which will enable accurate determination of the tripping or activation characteristics.
3) Perform mechanical operational tests in accordance with manufacturer's instruction manual. Manually exercise each operating mechanism, switches, circuit breakers, etc.
4) Check switchgear anchorage, area clearances, and alignment and fit of draw-out components in compartments. Verify switchboard, switchboard supports and attachments are designed and installed for appropriate seismic zone.
5) Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
6) Clean switchboard assembly using manufacturer's approved methods and materials.

g. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1) Insulation resistance test of buses and portions of control wiring that disconnect from solid-state devices through normal disconnecting features. Insulation resistance less than 100 megohms is not acceptable. Tests shall be made phase to phase, phase to neutral, and phase to ground with switches in the open and closed positions.
2) Ratio and polarity tests on current and voltage transformers, not integral with overcurrent protective devices.
3) Ground resistance test on system and equipment ground connections.
4) Calibration of ammeters and voltmeters at midscale.
5) Verify appropriate capacity, overcurrent protection, and operating voltage of control power elements including control power transformer and control power wiring.
6) Calibrate watthour and demand meters to 0.5 percent, and verify meter multipliers.
7) Provide operational test of each automatic breaker, alarm and indication. Provide manual tests initially and proceed to full automatic testing that tests each manual and automatic function, sequence and scenario. Verify and document each sequence including interlock, relay, etc. operation.
8) Tests of Overcurrent Protective Devices: Testing of overcurrent protective devices shall be conducted according to procedures outlined in overcurrent protective devices specification section.
9) Provide complete individual and system testing of ground fault devices and system.

h. Retesting: Correct deficiencies identified by tests and observations and retest switchboards. Verify by the retests that switchboards meet specified requirements.

C. Provide Operating and Maintenance Instructions in electronic format covering all equipment furnished. Manuals shall include the following information:

1. Name, address and telephone number of authorized service organization to be contacted for each equipment item.
2. Parts list and wiring diagram, operating and maintenance instructions for each piece of equipment.
3. Record Set of Shop Drawings: Shop drawings corrected to show as-built conditions. Transfer modifications from field set.
4. All wiring diagrams shall show color coding of all connections and mounting dimensions of equipment.
5. Provide Testing and Equipment Settings Report for each device indicating final configurations and settings.

3.6 CLEANING:

A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.7 PROTECTION:

A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendation within each section of switchboards throughout periods during which the switchboard is not in a space that is continuously under normal control of temperature and humidity.

3.8 DEMONSTRATION:

A. Training: Demonstrate and test switchboards and train Owner's maintenance personnel

1. Conduct a minimum of one half day of training in operation and maintenance as required under Division 1 Section on Project Closeout. Include both classroom training and hands-on equipment operation and maintenance procedures. Record training on disk and turn training disk over with O & M Manuals. Include training on all overcurrent devices, circuit monitors and other accessories as provided.
2. Schedule training with at least seven days advance notification

END OF SECTION 262413

SECTION 26 24 16 PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V or less.

1.2 DEFINITIONS:

A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

1.3 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
B. Shop drawings from manufacturers of panelboards including dimensional data. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type with details for types other than NEMA Type 1.
2. Bus configuration and current ratings.
3. Short-circuit current rating of panelboard and circuit breakers.
4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

C. Wiring diagrams detailing schematic diagram including control wiring, and differentiating between manufacturer-installed and field-installed wiring.

D. Report of field tests and observations.

E. Panel schedules for installation in panelboards. Submit final versions after load balancing.

1.4 QUALITY ASSURANCE:

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of panelboards and enclosures, of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

C. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects utilizing panelboards similar to those required for this project.

1.5 EXTRA MATERIALS:

A. Keys: Furnish six spares of each type for panelboard cabinet locks.

B. Touch-up Paint for panelboards: One half-pint container.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. General Electric Co.
2. Square D Co.
3. Siemens Energy & Automation, Inc.
4. Eaton

2.2 PANELBOARDS, GENERAL REQUIREMENTS:

A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated. Comply with Division 26 Section on Overcurrent Protective Devices, with OCPDs adapted to panelboard installation. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.

B. Enclosures: Cabinets, flush or surface mounted as indicated. NEMA Type 1 enclosure, except where the following enclosure requirements are indicated. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed mounting. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

1. NEMA 3R: Rain-tight

C. Front: Hinged trim type, secured to box with 1/4-20-large head slotted captive screws except as indicated. Front for surface-mounted panels shall be same dimensions as box. Fronts for flush panels shall overlap box except as otherwise specified. Provide fronts with hinged trim construction and door with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges on inner door, piano hinge on outer trim door, and door swings as indicated.

D. Directory Frame: Metal, mounted inside each panel door with card and clear plastic cover. Directory shall match panelboard configuration, i.e. top to bottom, left to right. Provide permanent panelboard labels for each circuit number.

E. Bus Material: Provide tin plated hard-drawn copper of 98 percent conductivity.

1. Provide alternate to provide tin-plated, high-strength, electrical grade aluminum alloy bus in lieu of copper.

F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductor’s bonded to box.

G. Provide lugs for incoming feeders and grounds compatible with bus and feeder material.

H. Service Equipment Approval: Listed for use as service equipment for panelboards having main service disconnect.

I. Provide minimum short circuit current ratings as indicated.

J. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.

2.3 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS:

A. Branch OCPDs: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Double-Width Panels: Where more than 42 poles are indicated, provide two panelboards of equal dimensions and with individual fronts on each panelboard.

2.4 DISTRIBUTION PANELBOARDS:

A. Branch-Circuit Breakers: Where OCPDs are indicated to be circuit breakers, use bolt-on breakers except circuit breakers 225-ampere frame size and greater may be plug-in type where individual positive locking device requires mechanical release for removal.

2.5 IDENTIFICATION:

A. General: Refer to Division 26 Section on electrical identification for labeling materials.

B. UL nameplates shall be provided for all panelboards. Information shall include, but not be limited to, manufacturer, model number, serial number, plant or manufacturing location, ampere rating, voltage rating, wire and phase identification and bus short circuit bracing rating.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install panelboards and accessory items in accordance with NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less" and manufacturers' written installation instructions.

B. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, "Application Guide for Ground Fault Circuit Interrupters."

C. Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish.

D. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Obtain approval before installing.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups, bundle, and wrap with wire ties after completion of load balancing.

G. Feeders to multiple section panelboards, from Sub-Feed Lugs or Feed-Through lugs shall match the feeders to the panelboard.

3.2 IDENTIFICATION:

A. Identify field-installed wiring and components and provide warning signs in accordance with Division 26 Section on electrical identification.

3.3 GROUNDING:

A. Connections: Make equipment grounding connections for panelboards as indicated.

B. Provide ground continuity to main electrical ground bus indicated.

3.4 CONNECTIONS:

A. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL:

A. Upon completing installation of the system, perform the following tests:

1. Make insulation resistance tests of panelboard buses, components, and connecting supply, feeder, and control circuits.
2. Make continuity tests of circuits.

B. Procedures: Make field tests and inspections and prepare panelboard for satisfactory operation in accordance with manufacturer's recommendations and these specifications.

C. Schedule tests with at least one week in advance notification.

D. Reports: Provide report written reports of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.

E. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating results of tests and inspections, responsible organization and person, and date.

F. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform of operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Verify that proper grounding bushings/bonding/ and panel enclosure bonding is complete.
6. Verify isolated neutral bar and neutral connections.

G. Electrical tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation resistance test of buses. Insulation resistance less than 100 megohms is not acceptable.
2. Ground resistance test on system and equipment ground connections.
3. Test main and sub-feed overcurrent protective devices in accordance with Section "Overcurrent Protective Devices."

Retest: Correct deficiencies identified by tests and observations and provide retesting of panelboards by testing organization. Verify by the system tests that the total assembly meets specified requirements.

3.6 CLEANING:

A. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marks of finish to match original finish.

END OF SECTION 262416

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.

B. Types of electrical wiring devices in this section include the following:

1. Receptacles.
2. Ground-fault circuit interrupters.
3. Switches.
4. Wall-plates.
5. Dimmers.
6. Plugs and connectors.
7. Concrete floor boxes

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical wiring devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.

C. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code", Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.3 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Samples of device plates for color selection and evaluation of technical features shall be submitted.

1.4 COORDINATION:

A. Wiring Devices for Owner Furnished Equipment: Match devices to plug connectors for Owner-furnished equipment.

B. Cord and Plug sets: Match cord and plug sets to equipment requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Products shall be of the same manufacturer insofar as possible. Subject to compliance with requirements, provide wiring devices of one of the following:

1. Devices, Cover Plates, Accessories:

a. Hubbell Inc.
b. Leviton Mfg. Co.
c. Pass and Seymour Inc.
d. Cooper Crouse-Hinds Co.
e. General Electric Co.

2. Concrete Floor Boxes:

a. Walker
b. Hubbell Inc.

3. Wiring Devices for Hazardous (Classified) Locations:

a. Crouse-Hinds Electrical Construction.
b. Hubbell-Killark Electrical Mfg. Co.
c. Pyle-National Co.

4. Weatherproof Receptacle Covers:

a. Hubbell, Inc.
b. Pass & Seymour / Wiremold Co. / Legrand
c. Eaton Wiring Devices
d. Leviton

2.2 WIRING DEVICES:

A. Color selection shall be verified with Architect/Engineer prior to ordering. Devices shall White. All receptacles and switches connected to circuits served from a generator system shall have a red face.

B. Receptacles:

1. All duplex, single, Isolated Ground, Tamper Resistant, Ground Fault Interrupter (GFCI), and other special receptacles shall be minimum, specification grade commercial series listed by Underwriter's Laboratories, UL 498 and Federal Specification FS W-C-596, 20 amp, nylon face and have a metal mounting strap with self-grounding and have a hex-head green grounding screw and be side and back wired. Each device shall bear the UL/FS Label. Meet NEMA standards for wiring devices including NEMA WD 1 for general requirements and NEMA WD 6 for dimensional standards.

a. Each device shall have terminal screws and clamps listed for use with stranded wire. Plug-tail device connections are acceptable.

2. Convenience Receptacle Configuration: Duplex or Single as indicated on the drawings, Type 5-20R.

3. Weather Resistant Receptacles: In addition to the above requirements all receptacles in damp and wet locations shall be WR (Weather Resistant) labeled.
4. Special Purpose Receptacle Configuration: straight blade or locking as indicated on drawings, black face.
5. Tamper Resistant Receptacles: Where indicated or required provide Duplex receptacle with integral switch and contacts to prevent energization unless a plug is inserted. Provide receptacles that are UL listed and labeled “TR”.
6. Ground-Fault Interrupter Receptacles: Where indicated or required provide "local reset" auto monitoring “self test” ground-fault circuit interrupters. Provide unit capable of being installed in a 2-3/4" deep outlet box without adapter, grounding type, Class A, Group 1 per UL Standard 943. Provide visual indication of lost protection.
7. Receptacles in Hazardous (Classified) Locations: Comply with NEMA Standard FB 11 "Plugs, Receptacles and Connectors on the Pin and Sleeve Type for Hazardous Locations" and UL Standard 1010 "Receptacle-Plug Combinations for Use in Hazardous (Classified locations."
8. Pendant Cord/Connector Devices: Matching, locking type, plug and plug receptacle body connector, NEMA l5-20P and L5-20R, heavy-duty grade.

    a. Bodies: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
    b. External Cable Grip: Woven wire mesh type made of high strength galvanized-steel wire strand and matched to cable diameter and with attached provision designed for the corresponding connector.

9. Cord and Plug Sets: Match voltage and current ratings and number of conductors to requirements of the equipment being connected.

    a. Cord: Rubber-insulated, stranded copper conductors, with type-SOW-A jacket. Grounding conductor has green insulation. Ampacity is equipment rating plus 30% minimum.

Plug: Male configuration with nylon body and integral cable-clamping jaws. Match to cord and to receptacle type intended for connection.

C. Switches:

1. Wall Switches for Lighting Circuits: NEMA WD1 and WD-6; FS W-S-896E; AC quiet type specification grade commercial series listed by Underwriter's Laboratories with toggle handle, rated 20 amperes at 120-277 volts AC, unless noted otherwise. Mounting straps shall be metal and be equipped with a green hex-head ground screw. Each switch shall bear the UL/FS Label.

    a. Each device shall have terminal screws and clamps listed for use with stranded wire. Plug Tail device connections are acceptable.

2.3 WIRING DEVICE ACCESSORIES:

A. Verify color and type with Architect/Engineer prior to ordering. Device color to match Wiring Device Color identified above. Verify location, height, mounting conditions, etc., of all devices with Architectural drawings prior to rough-in.

B. Wall-plates: Provide wall-plates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates. Identify all wall plates used for receptacles with branch circuit

number per requirements of section on Electrical Identification. Provide blank wall plates for all cable, data, telephone and junction and outlet boxes. Where cables are routed through the wall-plate, provide grommets in wall-plate openings to protect cables. Provide plates possessing the following additional construction features:

1. Material and Finish: 0.04" thick, **type 302 satin finished stainless steel**.
2. Material and Finish: 0.04" thick, type 302 satin finished stainless steel for use in unfinished areas, mechanical, and electrical rooms.
3. Wrinkle Finish: Steel, finish to be painted, color to be ivory unless otherwise noted.
4. Gaskets: Resilient rubber or closed cell foam urethane.
5. Weather Proof, Exterior and other wet locations and where called out on the drawings as “WP”, provide weatherproof junction box with gaskets and cover.

    a. “In Use” type: Cover shall be rated “while in use”. Use low profile type covers with UV rated and resistant polycarbonate.
    b. Outlet box hood shall be listed as “extra duty”.

6. Classroom Switch Cover Plates: Switch device plates in classrooms shall be metal engraved for lights controlled, panel identification, and circuit number.

C. Concrete Floor Box: Provide modular floor service outlets and fittings of types and ratings indicated. Construct of die cast aluminum, satin finish. Use design compatible with floor type and outlet wiring methods indicated. Provide 20-amperes, 125-volts, back-to-back duplex receptacles, NEMA configuration 5-20R. Provide with 1" NPT, 1" long, locking nipple for installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES:

A. Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

C. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.

D. Install wiring devices after wiring work is completed.

E. Install wall-plates after painting work is completed.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds. 486A.

G. Install telephone/power service poles in accordance with final furnishing arrangement. Poles shall be plumb, true, and secure.

H. Provide GFCI type outlets as shown and as required in the NEC including article 210, including but not limited to: each above counter duplex receptacle shown within 6 feet-0 inches of

sinks/lavatories; Bathrooms; Kitchens; Roof Tops; Outdoors; Indoor Wet locations; Locker Rooms; Shower Facilities; Garages; Service Bays; vending machines; etc. For above counter multi-outlet assemblies which do not contain duplex receptacles that can be replaced with GFCI devices, provide GFCI circuit breakers on the branch circuit(s) feeding the assembly. Where GFCI devices are required and/or shown but are not readily accessible when equipment is installed, i.e. vending machines, etc., provide blank face GFCI device and cover-plate ahead of inaccessible receptacles. Mount adjacent to equipment at switch height unless otherwise shown. Install individual GFCI devices at each location shown, feed through devices are only acceptable where specifically called for.

I. Provide Tamper Resistant receptacles as shown and required including: dwelling units; guest rooms; child care facilities; preschools/elementary facilities; business offices, corridors, waiting rooms, etc. in clinics, medical and dental offices, outpatient facilities, health care facilities including patient rooms, bathrooms, play rooms, activity rooms, and pediatric patient rooms other than nurseries, and subset of assembly occupancies.

J. Provide Dual function tamper-resistant AFCI/GFCI receptacles as shown and as required in the NEC including article 210.

K. Receptacle Mounting: Mount device with front of device flush with the cover plate. Over the counter receptacles shall be mounted horizontally with ground to the right. Where switch and receptacles are mounted within one stud space align vertically. Vertically mounted receptacles shall be mounted with ground up.

L. Switch Mounting: Switches shall be ganged and within 18” of the door jam on the strike side of the door openings unless otherwise shown. Verify door swings with Architectural drawings prior to rough-in. Switches connected to the life safety system shall not be ganged with other switches. Switch and receptacle combinations shall be installed in 2 gang box where both are of the same voltage. provide separate boxes where different voltages are present.

3.2 PROTECTION OF WALLPLATES AND RECEPTACLES:

A. Upon installation of wall-plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.3 GROUNDING:

A. Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounds.

3.4 CLEANING:

A. Internally clean devices, device outlet boxes and enclosures. Replace stained, cracked, damaged or improperly painted wall plates or devices. Remove temporary markings of labels.

3.5 TESTING:

A. Prior to energizing circuitry, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained and prepare test reports. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

1. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices or similar problems.
2. Tests for Convenience Receptacles:

    a. Line Voltage: Acceptable range is 114 to 126 V.
    b. Ground Impedance: Values of up to 2 ohms are acceptable.
    c. Polarity: Test for correct neutral conduct to neutral terminal connection.
    d. Using the test plug, verify that the device and its outlet box are securely mounted.
    e. GFCI Receptacles: Test for tripping values specified in UL 1436 and UL 943. Test with both local and remote fault simulations in accordance with manufacturing recommendations.
    f. SPD receptacle indicating lights for normal indication check.

3. Test Instruments:

    a. Use instruments that comply with UL 1436.
    b. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Correct Deficiencies and Report:

1. Correct unsatisfactory conditions and retest to demonstrate compliance; replace devices as required to bring system into compliance.
2. Correct malfunctioning units on-site, where possible and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Prepare a report that identifies enclosure, units, conductors and devices checked and describe results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

END OF SECTION 26 27 26

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SECTION 26 28 00 - LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

A. This section includes overcurrent protective devices (OCPD's) rated 600 V and below and switching devices commonly used with them.

B. Panelboards, and Switchboards: Application, installation, and other related requirements for overcurrent protective device installations in distribution equipment are specified in other Division 26 sections.

1.2 DEFINITIONS:

A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

B. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.3 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product data for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

C. Provide coordination study performed by a registered professional engineer in accordance with ANSI/IEEE Standards including 242 2001 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems,: where required to show proper coordination to the AHJ; when settings are not identified on the drawings; and where OCPD manufacturers other than those designated in the Device Settings Tables on the drawings or first in schedules or product listings in this specification are proposed for use, Study shall be a full coordination study showing graphically that the proposed OCPD's coordinate selectively with both upstream and downstream components. Include single line diagram with nodes corresponding to the system components as shown on the contract documents; coordinated time current curves and settings; device performance curves; fault current calculations adequate to demonstrate satisfactory component protection and selective coordination of protective devices; etc. Study shall include all Utility systems, overcurrent devices, transformers, buses, generator systems, grounding systems. etc., which comprises the AC power system, Bill of materials for devices and settings proposed shall be coordinated per the applicable sections of the current edition of the NEC, as required by the Authority Having Jurisdiction, and as a minimum to 0.01 seconds for Emergency systems and to 0.1 seconds for other systems. Study shall be commissioned and paid for by the Contractor. Submit study with overcurrent protective devices, switchgear, switchboard, and panelboard submittals.

D. Provide Electrical system Arc Flash Study performed by a registered professional engineer in accordance with ANSI/IEEE Standards. Submit a full coordination study with printed labels

affixed to each piece of equipment. Include single line diagram with nodes corresponding to the system components, Arc Flash calculations identifying hazard levels, etc. Study shall include all utility systems, overcurrent devices, transformers, buses, generator systems, grounding systems. etc., which comprises the AC power system, Study shall be commissioned and paid for by the Contractor. Submit study with switchgear, switchboard and panelboard submittals.

E. Submit documentation of compliance with Code and Specification requirements for circuit protective devices including but not limited to SCCR, Listings for use with downstream breakers/fuses and equipment where required, Ground Fault protection; Arc Flash reduction for breakers above 1200A; Surge Protection; Metering; Relaying; etc.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of overcurrent protective devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Each type of OCPD shall be the product of a single manufacturer.

1.5 EXTRA MATERIALS:

A. Spare Fuses: Furnish spares of each type and rating of fuse for fusible devices amounting to one set of 3 fuses for each 9 fuses installed but not less than 3 fuses of each type.

PART 2 - PRODUCTS:

2.1 MANUFACTURERS:

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

1. Cartridge Fuses:

a. Bussmann Div., Cooper Industries, Inc.
b. Littelfuse Inc.
c. Mersen

2. Fusible Switches:

a. General Electric Co.
b. Square D Co.
c. Allen-Bradley Co.
d. Siemens Energy & Automation, Inc.
e. Eaton

3. Molded-Case Circuit Breakers:

a. Square D Co.
b. General Electric Co.
c. Siemens Energy & Automation, Inc.
d. Eaton

4. Combination Circuit Breaker and Ground Fault Circuit Interrupters:

a. General Electric Co.

b. Square D Co.
c. Siemens Energy & Automation, Inc.
d. Eaton

5. When mounting overcurrent protective devices in switchboards, switchgear, panelboards, MCC's, etc., provide equipment of same manufacturer as equipment into which they are being mounted.

2.2 OVERCURRENT PROTECTIVE DEVICES (OCPDS), GENERAL:

A. General: Provide OCPDs in indicated types, as integral components of panelboards, switchboards, motor control centers, and other related equipment; and also as individually enclosed and mounted single units.

B. Enclosures: NEMA 250 "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

C. Where OCPD's are to be installed in existing panelboards, switchboards, and motor control centers, they shall be of the same manufacture and type as those existing in the equipment. If this is not possible, provide devices which are compatible with the existing equipment and when installed will not void the U.L. label or reduce the short circuit rating of the equipment.

D. All overcurrent devices shall be individually rated for the available fault current unless otherwise noted. Series ratings of equipment will only be allowed where specifically called out.

E. Ground Fault Protection: Distribution circuit breakers: provide integral, self-powered type with mechanical ground fault indicator, test function, adjustable pick-up current and delay time with inverse and constant time characteristics, internal memory arranged to integrate intermittent arcing ground faults, and ground fault current sensor located as indicated or required. Provide combination devices for branch circuit protection as follows; where shown or required provide 30 mA Ground Fault circuit breakers for each circuit feeding Electrical Heat Trace to protect from overheating and fire and 5 mA Ground Fault circuit breakers for each circuit feeding receptacles to protect personnel. Coordinate with manufacturer’s instructions.

2.3 CARTRIDGE FUSES:

A. General: NEMA Standard FU1, "Low-Voltage Cartridge Fuses." Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with the circuits on which used.

B. All fuses used for main, feeder, or branch-circuit protection shall be Underwriters Laboratories listed, current-limiting fuses with 200,000 ampere interrupting rating and shall be so labeled. Fuses used for supplementary protection (other than branch circuit protection) shall be as specified above or shall be U.L. approved or component recognized for such purposes. All fuses provided shall be furnished by the same manufacturer. Should equipment provided require a different U.L. Class or size of fuse, the engineer shall be furnished sufficient data to ascertain that system function will not be adversely affected.

C. In order to simplify fuse replacement, reduce spare fuse inventory and insure adequate thermal protection, all fuses 600 amperes and below shall be true dual-element time-delay fuses with separate spring-loaded thermal overload elements in all ampere ratings. All ampere ratings shall be designed to open at 400 degrees F or less when subjected to a non-load oven test.

D. To eliminate induction heating, all fuse ferrules and end caps shall be non-ferrous and shall be bronze or other alloy not subject to stress cracking.

E. Class L Fuses: UL 198C, "High-Interrupting Capacity Fuses, Current-Limiting Type."

F. Class RK1 Dual Element Time-Delay Fuses: UL 198E, "Class R Fuses."

G. Class J Low-Peak dual Element Fuse: UL 198C

2.4 NONFUSIBLE SWITCHES:

A. General: UL 98 "Enclosed and Dead Front Switches" and NEMA KS 1 "Enclosed Switches," quick-make, quick-break heavy-duty units.

B. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.

C. Withstand Capability: In excess of the available.

D. Operation: By means of external handle.

E. Interlock: Prevents access to switch interior except when in "off" position.

F. Enclosure for Independent Mounting: NEMA Type 1 enclosure except as otherwise indicated or required to suit environment where located.

G. Contacts shall be NEMA rated 75 degrees C.

H. Provide auxiliary contacts for disconnects supplied from variable frequency drives.

2.5 FUSIBLE SWITCHES:

A. General: UL 98 "Enclosed and Dead Front Switches" and NEMA KS 1 "Enclosed Switches," quick-make, quick-break heavy-duty units.

B. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.

C. Withstand Capability: In excess of the let-through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.

D. Operation: By means of external handle.

E. Interlock: Prevents access to switch interior except when in "off" position.

F. Fuse Clips: Rejection type.

G. Enclosure for Switchboard or Panel board Mounting: Suitable for panel mounting where indicated.

H. Enclosure for Independent Mounting: Provide NEMA Type 1 enclosure except as otherwise indicated or required to suit environment where located.

I. Contacts shall be NEMA rated 75 degrees C.

J. Provide fuses for safety switches and other equipment of classes, types, and rating needed to fulfill electrical requirements for services indicated.

K. Provide auxiliary contacts for disconnects supplied from variable frequency drives.

2.6 MOLDED-CASE CIRCUIT BREAKERS:

A. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."

B. Construction: Provide bolt-in type, except breakers 225-ampere frame size and larger which may be plug-in type if held in place by positive locking device requiring mechanical release for removal.

C. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating as indicated or required to match existing devices or equipment.

D. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole. Trip unit to be interchangeable within frame sizes for breakers 200 amperes or larger. Breakers 150 amperes and above shall have adjustable trip selection for trip units. All 120/208 volt rated breakers shall be rated and labeled "High Magnetic".

E. Adjustable Instantaneous Trip Devices: Factory adjusted to low-trip-setting current values. Provide adjustable instantaneous trip devices for each circuit breaker supplying individual motor loads and where indicated.

F. Enclosure for Switchboard or Panelboard Mounting: Suitable for panel mounting in switchboard or panelboards where indicated.

G. Enclosure for Switchboard Mounting: Provide individual mounting where indicated.

H. Enclosure for Independent Mounting: NEMA Type 1 enclosure, except as otherwise indicated or required to suit environment where located.

2.7 COMBINATION CIRCUIT BREAKERS AND GROUND FAULT CIRCUIT INTERRUPTERS:

A. General: UL 943 "Ground Fault Circuit Interrupters," arranged for sensing and tripping for ground fault current in addition to overcurrent and short-circuit current. Provide features as follows:

1. Match features and module size of panelboard breakers and provide clear identification of ground fault trip function.

2.8 OCPD ACCESSORIES:

A. Key Interlocks: Arrange interlocking so keys are held captive at devices indicated. Where future key interlocking provisions are indicated, provide necessary mountings and hardware as required for the future installation.

B. Provide adjustable-time-delay under-voltage trip devices where indicated.

C. Provide shunt-trip devices for Circuit breakers where required or indicated. Arrange to trip breaker from an external source of power through a control switch or relay contact.

D. Provide bell alarm contacts for tripped position.

E. Lock-Out Devices: Provide padlocking provisions on each overcurrent protective device, lockable in the open or closed position. Provide 3 sets of lockout/tagout devices for each type of breaker or switch provided. Include tags, locks and all accessories necessary.

F. Provide hand held battery powered trip unit power supply with labeled storage compartment for each switchboard.

G. Phase Monitoring Relay: Provide relay for each 3 phase motor or circuit indicated that is capable of automatic restart of equipment when adverse condition clears. Relay shall have solid-state 3 phase sensing circuit with isolated contacts for hard-wired connection to socket, Time mark or equal. Provide matching pin type relay and hold down clamps. Relay shall be arranged to operate on:

1. Phase failure, loss of supply voltage, phase reversal
2. Current unbalance of from 30 to 40 percent
3. Over and Under voltage: The ability for automatic re-start of equipment shall be provided. Settings shall be 110% for overvoltage and 80-95% for under voltage.
4. Voltage and current unbalance: Settings shall be 10-15% of FLA for current unbalance alarm with 5-10 second delay and 20-25% of FLA for current unbalance trip with 2-5 second delay, Phase imbalance shall be adjustable from 2 to 10% with disable setting.

H. SPARE FUSE CABINET:

I. Cabinet: Where indicated on the drawings and for all new construction projects when fuses are included in work, provide wall-mounted, 18-gauge minimum steel unit with full-length, recessed piano-hinged door with key-coded cam lock and pull. Size to be adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum. Cabinet finish to be gray baked enamel. Stencil legend "SPARE PARTS/FUSES" in 1-1/2 inches (40-mm) letters on door.

PART 3 - EXECUTION:

3.1 INSTALLATION:

A. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions. Install OCPDs level and plumb.

B. OCPDs in new distribution and branch circuit equipment shall be factory installed. OCPD's in existing distribution and branch circuit equipment shall match existing for type and be provided with features as listed herein.

C. Install fuses in fusible devices as indicated. Arrange fuses so that fuse ratings are readable without removing fuse.

D. All fuses for new disconnect switches or MCC’s feeding motors or motor starters shall be provided with Class J fuses.

E. OCPDs and mounting accessories installed in existing equipment shall match the existing manufacturer and be rated for the available fault current.

3.2 IDENTIFICATION:

A. Identify components in accordance with Division 26 Section on electrical identification.

3.3 CONTROL WIRING INSTALLATION:

A. Install wiring between OCPDs and control/indication devices.

3.4 CONNECTIONS:

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.5 GROUNDING:

A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.6 FIELD QUALITY CONTROL:

A. Reports: Prepare written reports on tests and observations. Report defective materials and workmanship, and unsatisfactory test results. Include complete records of repairs and adjustments made. Tests shall be made on all new and existing OCPD's provided and/or connected under this project in accordance with this section.

B. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

C. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.

D. Upon completing installation of the system, perform the following tests on all new equipment and existing equipment as indicated on the drawings:

1. Visual and mechanical inspection: Include the following inspections and related work.

    a. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters.
    b. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
    c. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
    d. Check tightness of electrical connections of OCPD’s with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
    e. Clean OCPD’s using manufacturer's approved methods and materials.
    f. Verify installation of proper fuse types and ratings in fusible OCPD’s.

2. Electrical Tests: Perform the following tests in accordance with manufacturer's instructions:

    a. Insulation resistance test of fused power circuit devices, insulated-case, and molded-case circuit breakers, 600-ampere frame size and over at 1000 degree V D.C. for one minute from pole to pole and from each pole to ground with breaker

closed and across open contacts of each phase. Insulation resistance less than 100 megohms is not acceptable.

b. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.

c. Make continuity tests of circuits.

d. Provide full rated primary current tests conforming to IETA testing standards of all new and existing breakers 800 amperes and greater including Ground Fault systems testing, connected under this project. Inspect breakers and provide test report. Set breakers to previous or new settings as directed prior to test.

e. Verify relay operation by introduction of accurately metered currents into overcurrent/ground fault/ and other circuitry at values which will enable accurate determination of the tripping or activation values.

E. Make adjustments for final settings of adjustable-trip devices.

F. Activate auxiliary protective devices such as ground fault or under-voltage relays, to verify operation of shunt-trip devices.

G. Check stored-energy charging motors for proper operation of motor, mechanism, and limit switches.

H. Check operation of electrically operated OCPDs in accordance with manufacturer's instructions.

I. Check key and other interlock and safety devices for operation and sequence. Make closing attempts on locked-open and opening attempts on locked-closed devices including moveable barriers and shutters.

J. Retest: Correct deficiencies identified by tests and observations and provide retesting of OCPDs by testing organization. Verify by the system tests that specified requirements are met.

3.7 CLEANING:

A. Upon completion of installation, inspect OCPD’s. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8 DEMONSTRATION:

A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPD’s and train Owner's maintenance personnel. //OR Demonstrate OCPD’s and train Owner's maintenance personnel.

B. Conduct a minimum of one half day of training in operation and maintenance as specified under in the Project Closeout Section of these specifications. Include both classroom training and hands-on equipment operation and maintenance procedures.

C. Schedule training with at least seven days' advance notification.

END OF SECTION 26 28 00

SECTION 26 32 13 – ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY:

A. Extent of diesel generator set work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, diesel engine, electrical generator, engine starting system including batteries, instrument control panel, weather-protective housing, transfer switches, subbase fuel tanks, day tank(s), annunciator panel, exhaust silencer, wall thimble, and accessories.

B. System Description:

1. Diesel engine-driven generator to provide source of stand-by and/or emergency power-ESP.

C. Concrete and grout work for engine-driven generator pads, foundations, frames and bedplates are specified in Division-3 "Concrete" sections.

D. Main fuel tanks, piping, ductwork, temperature controls and associated accessories required for installation of diesel engine-driven generator units are specified in Division 23 sections.

1.2 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product Data: Submit manufacturer's data on diesel engine-driven generator sets and components and include a copy of the manufacturer's standard product warranty.

C. Checklist: Submit a detailed checklist which acknowledges compliance or a reason for non-compliance to each of the specification requirements. Arrange the checklist according to the headings of each item identified in this specification (i.e. Shop Drawings, Wiring Diagrams individual line items, etc.) Mark items as "N/A" where the item is not applicable.

D. Shop Drawings: Submit ½ inch scale dimensioned plan and elevation layout drawings of diesel engine-driven generator units and accessories being supplied, including, but not limited to, generator, engine control panel, master control panel, fuel line piping, fuel tanks and related equipment, batteries, battery racks, battery chargers, remote start-stop stations, instrumentation, and transfer switches or breakers. In addition, show diesel generator set unit and its spatial relationship to associated equipment. Allow adequate clearance space for removal of engine generator elements for maintenance purposes. The drawings shall be for the particular unit to be supplied, with all other information removed.

E. Wiring Diagrams: Submit wiring diagrams for diesel engine-driven generator unit showing connections to generator output breaker, control panels, transfer switches or breakers, alarms, remote alarms and ancillary equipment. Show and differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed. The unit diagrams shall be for the particular unit to be supplied with all other information removed.

1. All interconnection and wiring diagrams shall include the following information as a minimum:

a. Complete diagrams of the internal wiring for each of the items of equipment. The diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

b. Diagrams shall include all field wiring and labeled terminals for connections including all controls, alarms, and customer connections.

c. Submit BAS interface layouts for Alarms that communicate through the local BAS system using BACNET.

2. In addition to paper copies of the interconnecting and wiring diagrams, an AUTOCAD, electronic file shall be submitted for each diagram.

F. Certifications:

1. Provide diesel engine-driven generator set's manufacturer certified test record of the final production testing prior to shipping the unit from the factory to the project site. Include the following tests:

a. Single-step load pickup.
b. Transient and steady-state governing.
c. Safety shutdown device testing.
d. Voltage regulation.
e. Rated power.
f. Maximum power.

G. Factory Testing: Standard diesel engine and generator tests shall be performed before, during, and after unit assembly. Submit a factory test log of diesel engine-alternator set showing a minimum of four (4) hours testing at 100 percent rated load to the Owner prior to shipment of the generator set. Load testing shall have a 0.8 power factor lagging continuously.

1. All engine safety features shall be tested for operation and calibrated prior to the load test.
2. All control and relay functions shall be tested for proper operation.
3.
4. All tests shall be conducted as close to the listed maximum ambient temperature as practical. The actual radiators to be installed shall be used.
5. The following engine run data shall be recorded at 15 minute intervals:

a. Time
b. kW output
c. Output Voltage
d. Amperes
e. RPM
f. Input water temperature
g. Output water temperature
h. Input oil temperature
i. Fuel pressure
j. Oil pressure
k. Ambient temperature
l. Radiator inlet air temperature, if different than ambient.

6. All test sheets will be submitted at the completion of the test. The vendor shall contact the Owner for scheduling and coordination of the factory test. Owner personnel or an Owner representative shall have the opportunity to witness the test.

H. Submit engine horsepower curves indicating manufacturer's approval of the engine rating for standby power application based on actual testing of a similar package. Special ratings or "maximum" ratings are not acceptable.

I. Provide information on the content and capacity of exhaust gases emitted by the engine at 1/4, 1/2, 3/4, and full load. The exhaust gas omission shall comply with all Federal, State and Local Codes in force at the site location.

J. Submit de-rating data, calculations, and final unit rating for the specified operating conditions at the site, where they differ from the vendor’s stated standard operating conditions.

K. Submit the generator harmonic analysis report for the 3rd, 5th and 7th harmonics that shows compliance with this specification.

L. Time-Current Curves for generator protective device with Thermal damage curve for generator in electronic format suitable for use in Power Tools Dapper/Captor software.

M. Sound Test data.

N. Submit Statement of compliance which states the proposed products are certified to the emissions standards required by the location for EPA, stationary emergency application and State and Local requirements.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of diesel engine-driven generator units and ancillary equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

1. The engine-generator shall be assembled, thoroughly tested and warranted, as the product of a single manufacturer. Sets which are assembled components by a service type facility are not acceptable.

2. The engine-generator set supplier shall be fully capable of providing all site service work on the engine-generator set and all accessories including:

   a. Repair or replacement of any component including large assemblies such as generator rotors, drive shafts, etc.
   b. Testing and trouble shooting.
   c. General maintenance.

3. The engine generator set supplier shall have in local stock, all customary parts required for service of the unit including engine parts and electrical assemblies at a local central location 24 hours per day, 365 days per year.

4. The engine generator set supplier shall maintain a service shop located within 200 miles from the job site and shall have fully equipped service trucks with mechanic/technicians available and on-call 24 hours per day.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with diesel engine-driven generator units similar to that required for this project.

1. Agreement to Maintain: The Installer must be willing to execute with the Owner, an agreement for continued maintenance of diesel engine-driven generator units.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Deliver diesel engine-driven generators properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for engine-generator and components which protect equipment from damage.

B. Store diesel engine-driven generator equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle diesel engine-driven generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide diesel generator sets of one of the following:

1. Cummins/Onan Engine Co.
2. Caterpillar.
3. Kohler Corp;
4. Waukesha Engine Div. Natural gas only
5. Detroit Diesel
6. Generac

2.2 RATINGS:

A. The engine-generator set shall have the following minimum measured ratings when installed at the specified site and all derating factors including those for temperature, altitude, fan, charging generator, water pump, etc. are considered.

1. Duty: Standby
2. Kilowatts:200 KW
3. Power Factor: 0.8 Lagging
4. Frequency: 60 Hz Nominal
5. Voltage: 120/208
6. Phase: 3
7. Wire: 4
8. Synchronous Speed: Standby:1800 RPM.

2.3 ENVIRONMENTAL CONDITIONS:

A. The equipment specified is intended for application in an environment as described below:

1. Altitude: Sea Level to 2600 feet.

2. Maximum Temperature: Outdoor: 110 degrees F
3. Minimum Temperature: Outdoor: -20 degrees F
4. Location: Outdoor
5. Relative Humidity:0-95%.

2.4 ENGINE:

A. Type: direct fuel injected, liquid cooled with unit mounted radiator and engine driven water pump, multi-cylinder inline or v-type, four stroke, compression ignition diesel, internal combustion engine. Diesel engine shall comply with the requirements of SAE 1349, ISO 8528 (Part 2), EGSA 101P and IEEE Standard 446 as they apply to standby application.

B. Fuel System: Appropriate for use of No. 1 or 2 fuel oil.

C. Governor: Adjustable Isochronous type to maintain governed speed at rated frequency regardless of the kW load and shall meet the following requirements:

1. Stability: 0.25 percent maximum frequency variation at any constant load from no load to full load.

2. Regulation; 0.25 percent maximum frequency deviation at steady state.

3. System shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

D. Engine Accessories: Provide the following engine accessories.

1. Fuel filter.
2. Lube Oil Pump-Positive displacement, mechanical, full pressure pump.
3. Lube oil filter and strainer.
4. Crankcase Drain- arranged for complete gravity drainage to easily removable container with no disassembly and no use of pumps, siphons, special tools, or appliances.
5. Provide engine with an initial fill (including oil makeup tank) of manufacturer’s recommended multi-viscosity lubricating oil.

6. Provide a valved oil drain extended past the engine frame with braided stainless steel hose and reusable fittings.
7. Intake air filter.
8. Lube oil cooler.
9. Fuel transfer pump as required by manufacturer for site conditions.
10. Fuel priming pump as required by manufacturer for site conditions.
11. Gear-driven water pump.
12. Lube Oil Pressure gauge.
13. Lockable fuel Cap.

E. The engine shall be designed to develop rated speed and torque capable of developing full load within 8 seconds from the time the engine starts. Engine cranking period shall not exceed 30 seconds. In addition, comply with NFPA 110, Level 1, Type 10 system requirements including load transfer within 10 seconds.

F. The engine shall be equipped with protective devices to meet control requirements specified elsewhere in this specification. The control devices shall be tied into the engine generator

control. All protective devices shall be wired into a master engine terminal box with terminal strips for remote connections and connections to annunciators or controls as required.

G. All equipment shall operate with minimum vibration throughout the operating range as assembled units. The equipment supplier shall assume all additional shop, shipping and transportation expense, and/or cost at the job site necessary to reduce excessive vibration attributable to unbalance of the equipment.

2.5 GENERATOR CHARACTERISTICS:

A. The generator shall be provided in accordance with the following:

1. The generator shall be of the single-bearing type, drip proof construction, externally regulated, directly connected to the engine flywheel through a semi-flexible coupling. The generator shall be complete with inboard brushless exciter. The generator rotor shall be dynamically balanced to withstand over-speeds up to 125 percent rated speed and heat during operation at 110 percent of rated capacity without damage from mechanical, electrical, thermal, or vibration.
2. The generator shall comply with NEMA Standard MG-1, latest revision. Insulation shall be Class H. Rotor and stator temperature rise shall not exceed 105 degrees C. over a 40 degree C. ambient temperature at specified site altitude. Generator must be derated in accordance with NEMA MG-1.
3. Submit generator sub transient reactance to meet specified voltage distortion and to allow proper short circuit and overload system coordination. Submit generator protection on time/current curves that show proper coordination including generator FLA, generator damage curve, generator decrement curve, protective relays, and circuit breaker settings.
4. The generator shall be capable of continuously delivering its rated output at any power factor from 1.0 to 0.8 lagging at ±5 percent of rated voltage and at 60Hz, in the environmental conditions as specified.
5. Insulation shall be 100 percent epoxy material, pressure impregnated.
6. Stator winding shall be of 2/3 pitch design unless otherwise noted or to parallel with existing generators.
7. Total harmonic distortion of output waveform shall not exceed 5 percent total RMS voltage measured line to line at rated load.
8. The generator voltage regulator shall be SCR type, separate from exciter, solid state, microprocessor-controlled, full wave rectified, with pulse-width modulated signal to the exciter. Provide external voltage adjust rheostat. Provide a setscrew stability adjustment. Voltage regulation shall be +/- 1.0 percent. Steady state voltage stability shall remain within a 0.5 percent band of rated voltage from no load to full load.
9. Provide PMG-Permanent Magnet Generator and controls to limit a sustained short circuit by excitation control to approximately 3 times FLA for both symmetrical and asymmetrical cases. If PMG is not available for specific engine/generator size, relay or circuit breaker and ground fault protection shall be provided to limit current below the alternator thermal damage curve.
10. The engine alternator shall be capable of accepting a one-step application of 100% of nameplate kW load at 0.8 power factor and recover to steady state conditions without disruption of power to the load and within 10 seconds. When the alternator is sequentially loaded with rated full load in two equal steps, the transient voltage drop at any step shall be limited such that the alternator voltage is not less than 80% of nominal voltage, and frequency is not less than 91% of nominal. In addition, the voltage at the alternator shall recover to within 90% of nominal voltage and the frequency to within 97% of nominal within 4 seconds after each sequential load application, or 60% of each step time interval (whichever is less).

11. During recovery from transients caused by step-load increases, step-load decreases, or resulting from 100% load rejection, the speed of the diesel alternator set shall not reach the over speed shutdown setpoint.
12. The generator shall be capable of providing 300 percent of rated full load current for ten seconds during a 3 phase bolted short circuit condition at system output terminals. For a 1 phase, bolted short circuit at the system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
13. The generator shall be of twelve lead design and connected in three phase, 4 wire/wye configuration. Neutral capacity shall be 100 percent of each phase.
14. Telephone influence factor (TIF) shall not exceed 50.
15. Generator bearing shall be designed for a minimum B-10 bearing life of 40,000 hours. The bearing shall be of the shielded type with provisions for lubricating without opening terminal compartment.
16. For multiple engine/generator applications, coordinate generator pitch/impedance, and other factors of each new and existing system for proper paralleling characteristics.
17. All generator leads (including neutral) shall be extended un-spliced from windings to generator connection junction box external to generator.
18. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
19. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
20. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
21. Output Waveform: at full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic.
22. Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.6 STARTING EQUIPMENT:

A. General: The engine shall be equipped with an electric starting system of sufficient capacity to crank the engine at a speed which will allow starting of the engine. System shall be 12 volt.

1. Starting system shall be capable of starting the engine either manually or automatically.

B. Batteries:

1. The batteries shall be dedicated to the engine.
2. The battery shall be suitable for continuous operation, within the temperature range of -20 degrees C and +40 degrees C and able to operate adequately with occasional temperature excursions of up to +60 degrees C.
3. Rigid connections shall be manufactured of nickel plated high quality copper bar. Flexible inter-cell connections shall be made out of copper cable with appropriate insulation. Nickel plated lead, or nickel plated steel are not acceptable for flexible or rigid connections. The battery cables shall be welding type cable using compression connectors and shall have physical protection. Provide corrosion inhibiting compound on all cable terminations.
4. Provide maintenance free lead acid batteries having sufficient capacity for cranking the engine continuously for at least 45 seconds and Cycle crank (3 cycles) for at least 75

seconds at firing speed in the minimum ambient temperature specified. . Batteries shall be sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum. Cranking Cycle shall be as required by NFPA for level 1 systems.

5. The cell container shall be made of high impact translucent polypropylene with clearly marked maximum and minimum electrolyte levels. All cell data such as battery type, manufacturer's name, electrolyte level marks shall be displayed clearly. Each cell shall have terminal voltage of 1.2 volts DC nominal voltage. The lid shall be thermally welded onto the cell container to eliminate any risk of electrolyte leakage. Gluing or chemical bonding is not acceptable.
6. The battery electrolyte shall be an aqueous solution of potassium hydroxide with a specific gravity of approximately 1.20. Lithium hydroxide may be used as an additive. There shall be no need to change the electrolyte over the life of the battery.
7. The battery positive and negative terminals shall be of threaded type. The positive terminal shall be identified by a red plastic disc at the base.

C. Accessories:

1. Provide a battery rack and necessary cables and clamps. Size battery cables per engine manufacturer data for cable length as required. Include required interconnecting conductors and connection accessories.
2. Each battery shall be mounted on a free standing steel rack protected with alkaline resistant epoxy paint. Battery rack shall be grounded and anchored to the floor. Verify rack dimensions with field conditions indicated on plans to ensure rack will fit in location specified. Battery rack shall be designed and secured to match the specified seismic zone.
3. A suitable battery charging alternator shall be provided with sufficient capacity to recharge the batteries back to normal starting requirements within 90 minutes.
4. Provide battery blanket for 120 volt a.c. supply with controlling thermostat.
5. Provide continuous clear non-conductive covers for each row of terminals in rack.

D. Battery Charger:

1. Provide a battery charger specifically designed for engine starting batteries which shall maintain the starting batteries at full charge. The charger shall be capable of restoring the batteries to a fully-charged state within eight hours after a complete duty cycle discharge and 4 hours after a normal engine starting sequence.
2. The charging system shall permit charging from either a normal or emergency 120 volt AC power source.
3. The charger shall be so designed that it will not be damaged during the engine cranking.
4. The charger shall be a three stage with solid state voltage regulation, temperature stabilized type with automatic and manual charge control. The three stages consist of boost mode 28.8V for charging to 90% of battery capacity, normal mode 27.3V to safely complete the charge and storage mode 26.40V to minimize battery outgassing. The actual output of the charger to be provided shall be the sum of start battery C/10 capacity plus the continuous DC control power requirements (10 ampere capacity minimum). Additionally, the battery charger shall have an equalization mode: every 21 hours when the system is operating in the storage mode, the charger will automatically switch to the equalizing mode, which increases the charging voltage up to 28.8V for 15 minutes to minimize battery sulfation.
5. Charger shall be Automatic Temperature Compensating to prevent overcharging at high temperatures and undercharging at low temperatures.

6. Charger shall be Automatic Voltage Regulating to maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
7. The charger shall be properly treated for NEMA 1 with chemical resistant epoxy coating.
8. The charger shall be equipped with the following accessories, as a minimum:

    a. Ammeter
    b. Voltmeter
    c. Fused AC input and fused DC output
    d. AC input failure contacts for alarms
    e. DC output failure contacts for alarms
    f. High Volts (red)
    g. Low Volts (red)
    h. Rectifier fail (red)
    i. AC fail (red)
    j. Float mode status (green)
    k. High rate status (amber)

    l. Relay contacts for fault conditions as required by NFPA.

    m. Safety Functions; Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery charger malfunction indication at system control and monitoring panel.

2.7 COOLING SYSTEM:

A. Provide the engine with a liquid cooled unit mounted radiator. Radiator fan shall be of the pusher type. Radiator shall be rated for the specified ambient temperature and shall be of the de-aeration type. Provide cooling system components and meet requirements as follows:

1. Provide each engine with a dedicated system of radiator, pumps, piping controls and alarms.
2. Provide a radiator auxiliary pump (if required) with starter.
3. Provide radiator fan, motor and starter. The fan shall be direct drive and have guards to OSHA Standards.
4. Where the radiator is located above the engine, provide heat exchanger if the hydraulic head will be greater than the manufacturer’s recommendation for the engine.

    a. Provide heat exchanger capacity 15 percent greater than the engine heat rejection.

5. Noise level shall be a maximum of 75 dB at 23 feet. (7m.).

B. Provide spin-on type water filters with anti-scale agent.

C. The engine cooling system shall be filled with anti-freeze with a mixture of ethylene glycol antifreeze in water appropriate to protect the engine at 20degrees below the minimum ambient temperature specified. Provide anticorrosion additives as recommended by engine manufacturer. Provide glycol for complete piping and radiator system.

D. Provide radiator overflow tank adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

E. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine. Equip with gauge glass and petcock.

F. Temperature Control: provide self-contained, thermostatic-control valve that modulates coolant flow automatically to maintain optimum constant coolant temperature.

G. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange as coordinated with other trades

H. Provide Engine Coolant temperature gage.

I. Provide a valved radiator drain with pipe extension and threaded connection at a location easily accessible to maintenance personnel.

J. Provide OSHA guards on all belts, pulleys and fans.

K. Provide necessary pipe fittings. Provide necessary valves for ease of access and maintenance.

L. Provide minimum of two belts to radiator fan drive

2.8 AIR INTAKE SYSTEM AND EXHAUST SYSTEM:

A. Provide a dry type air intake filter and silencer. Mount on the engine in an accessible location.

B. Provide a stainless steel, corrugated, flexible exhaust pipe in between the engine exhaust flange and silencer to prevent the transmission of vibration. Minimum length shall be 18 inches.

C. Provide critical type exhaust silencer.

1. Provide exhaust silencer mounting bands and brackets.
2. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator while it is delivering 110% of its specified rating.
3. Exhaust pipe size from the engine to the muffler shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two pipe sizes larger than engine exhaust pipe.
4. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.
5. Condensate drain at muffler shall be made with schedule 40 black steel pipe through a petcock.
6. Exhaust Piping and Supports: Black steel pipe, ASTM A-53 standard weight with welded fittings. Spring type hangers, as specified in Section 23 shall support the pipe.
7. Insulation for Exhaust Pipe and Muffler:

    a. Calcium silicate minimum 3” (in.) thick or as recommended by the silencer manufacturer.
    b. Insulation shall be as specified in Section 23 for HVAC, Plumbing, and Boiler Plant Insulation.
    c. The installed insulation shall be covered with aluminum jacket 0.016” (in.) thick. The jacket is to be held in place by band of 0.015” (in.) thick by 0.5” (in.) wide aluminum.
    d. Insulation and jacket are not required on flexible exhaust sections.

e. Roof Sleeves: Pipe sleeves (thimble) shall be Schedule 40 standard weight steel pipe. Flash exhaust pipe thimble through roof with 16 oz. soft sheet copper, flanged, and made watertight under built-up roofing and extended up around pipe thimble. The exhaust pipe shall be positioned within the thimble by four-6”
f. (in.) wide spiders welded to the exhaust pipe.

8. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing rain cover.
9. For engine-generators mounted in outdoor enclosures, the silencer shall be mounted inside the enclosure.
10. Air intake filter: Provide engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

D. Provide flanges, non-slip type connectors and gaskets. Exhaust lines shall be gas tight. Connections are to be welded and/or flange type.

2.9 FUEL SYSTEM:

A. Provide double walled base mounted fuel tank and fuel system designed for #2 / #1 fuel oil.

B. Tank shall meet the following requirements:

NFPA 30 and 30A

Idaho Department Environmental Quality Rules Regulating Underground Storage Tank Regulations 58.01.07

UL142 requirements for Above Ground Double Wall Steel Storage Tanks

Provide fuel tank with sufficient capacity to operate the system at 100 percent kW load for 48 hours continuously.

C. Provide necessary pumps, floats, piping and connections including connections to external fuel fill via a drop tube. Plumbing and wiring shall be pre-connected and supplied integral with the generator package.

D. Provide full fuel tank at the end of this project. Fuel tanks shall have initial fill for testing and be refilled when testing demonstration, and training is complete with specified diesel fuel.

E. Provide the following accessories:

1. Sub Base mounted Tanks and Day Tanks:

a. Calibrated fuel level stick.
b. Tank drain
c. Provide interstitial monitoring and alarm to detect a fuel leak between tank walls.
d. Normal vent piping with a spark arrestor at the end of the vent line when installed in areas with flammable materials present and where required by any agency or jurisdiction. Spark arrestor must be located “in the clear” and at least 12 feet above ground level.
e. A check valve and a shutoff valve with a quick-connect coupling or a dry-break valve which is installed in the piping at a point where connection and disconnection is made for delivery fuel.

f. Overfill protection – the equipment shall automatically stop the delivery of liquid to the tank when the liquid level in the tank reaches 95 percent of capacity or sound an audible alarm when the liquid level in the tank reaches 90 percent of capacity.
g. Weatherproof signage as required by NFPA 704.
h. Fuel level gauge.
i. “Press to test” switch.
j. Heavy duty float switch.
k. Provide for day tank systems:

1) Integral electric fuel transfer pumps.
2) Provide ability to drain tank using fuel return pump.
3) “Pump running“ indicator.
4) Bronze gear pump with stainless steel shaft.

F. Controls shall cycle transfer pump to maintain fuel level in day tank.

G. An application for tanks larger than 660gallons must be submitted to and approved by the Director of the Idaho Department, before beginning construction on any new petroleum AST system at a particular facility; or before beginning construction on any existing petroleum AST system at a facility that is being upgraded to the current applicable State standards.

H. Submit a visual inspection record of the tank at the conclusion of the project. Submit using forms recommended by the State.

STARTING AIDS:

I. Provide AC single phase engine jacket water heaters installed on the engine. The heaters shall be sized to provide an engine jacket temperature of 90 degrees F. in the minimum ambient temperature specified. Provide isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss. Provide 12VDC thermostat, installed at the engine thermostat housing.

2.10 MOUNTING:

A. Provide a suitable full length sub-base for mounting the engine generator unit on a concrete foundation. Provide Lifting attachments, total package weight, and indicate center of gravity for rigging on unit mounted label. Maintain alignment of mounted components without depending on foundation.
B. Provide vibration isolation between engine-generator and sub-base/sub-base fuel tank. Sub-base/sub-base fuel tank shall be bolted into concrete inserts for lateral movement limitation.

C. Mounting shall be designed, constructed, and installed to meet applicable seismic zone requirements.

2.11 ENGINE GENERATOR CONTROL PANEL:

A. Provide a NEMA 1 (indoors) and NEMA 4 (outdoors or in other locations exposed to weather) automatic starting control panel, powered via engine start batteries. Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

1. Engine Generators 250 kW and below: The control panel shall be installed on the generator facing the rear of the unit.

   Engine Generators above 250 kW: The control panel shall be designed for floor mounting.

B. The engine generator control panel shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit and be equipped with the following items:

1. Provide the following analog meters with 2% accuracy, minimum size 2-1/2" meters for engine mounted control panel and 4-1/2“ meters for floor mounted control panel:

   a. Generator ammeter: 3-Phase with simultaneous display of each phase.
   b. Generator voltmeter: 3-Phase, line to line and line to neutral with simultaneous display of each phase.
   c. Generator frequency meter
   d. Generator kilowatt meter: Total and for each phase and indicate power flow direction.

2. Manual/Off/Reset/Automatic selector switch.
3. Voltage level adjustment rheostat.
4. Accessory output contact which closes when the generator starts, for interlocking with remote items. Wire to terminal strip.
5. Fuel level gauge.
6. Lube oil pressure gauge.
7. Alarm silence.
8. Parallel relays from each pre-alarm and alarm condition with dry contacts wired to alarm terminal strip.
9. Elapsed time meter.
10. Alarm lamp test pushbutton.
11. Fuel pressure gauge.
12. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating. Pushbutton shall be flush wall mounted unless otherwise indicated and shall be protected from accidental operation.
13. Fault Reset Switch: supply a dedicated control switch to reset/clear fault conditions.
14. Running Time Meter.
15. Generator Voltage and Frequency digital raise/lower switches: Rheostats for these functions are not acceptable. The control shall adjust these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values).
16. AC Protective equipment: The control system shall include over/under voltage, over current, short circuit, loss of voltage reference, and over excitation shut down protection. There shall be an overload warning, and overcurrent warning alarm.
17. Status LED indicating lamps to indicate remote start signal present at the control, existing alarm condition, not in auto, and generator set running.
18. Graphic display panel with appropriate navigation devices shall be provided to view all information noted above as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
19. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.

20. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking). Adjustable Start/Stop time delay.
21. Water temperature gauge.

C. Control Start Sequence:

1. Automatic operation: Upon a remote contact closure from one or more automatic transfer switches, the auto-start panel shall automatically provide up to four cranking periods of ten seconds each with up to three rest periods of ten seconds in between. Should the engine fail to start, an over-crank timer shall lock out the engine from further attempts, sound an alarm, and provide an output contact closer for a remote alarm.
2. When mode is set to “ON” generator-set starts.
3. When mode is set to “OFF” the control panel initiates generator-set shutdown.
4. Operation of the local generator-set mounted and/or remote emergency-stop switch also shuts down generator-set.
5. When generator set is running, specified and required system or equipment failures or derangements automatically shut down generator set and initiate alarms.

D. Provide a local and remote LED alarm annunciator with audible and visual indications as listed below and to comply with NFPA 110 Level 1.

1. Provide with test/cancel pushbuttons, audible alarm silencing switch, contacts for local and remote alarms.
2. Locate the alarm panel in the engine generator control panel.
3. The annunciator shall alarm the following conditions:

Alarm	Type	Control Panel Annunciator	Remote Annunciator
Low lube oil pressure	Pre-alarm	Amber	Amber
Low lube oil pressure	Alarm/shutdown	Red	Red
High coolant temperature	Pre-alarm	Amber	Amber
High coolant temperature	Alarm/shutdown	Red	Red
Low coolant level	Pre-alarm	Amber	Amber
Low coolant temperature (<70 degree F/20 degree C)	Alarm	Amber	Amber
Over-crank	Alarm/shutdown	Red	Red
Over-speed	Alarm/shutdown	Red	Red

Alarm	Type	Control Panel Annunciator	Remote Annunciator
Overvoltage	Alarm/shutdown	Red	Red
Under-frequency	Alarm/shutdown	Red	Red
Control switch off normal	Alarm	Flashing red	Flashing red
Engine breaker open	Alarm	Red	Red
Battery charger low DC voltage/output failure	Alarm	Amber	Amber
Emergency stop	Alarm/shutdown	Red	Red
Water in fuel	Alarm	Red	Red
Ground fault	Alarm	Red	Red
Low fuel- main tank	Alarm	Red	Red
Emergency power system (EPS) supplying load	Alarm	Red	Red
High starting air pressure (when used)	Alarm	Red	Red
Low starting air pressure (when used)	Alarm	Red	Red
Low starting hydraulic pressure	Alarm	Red	Red
Air shutdown damper (when used)	Alarm/shutdown	Red	Red
Low cranking voltage	Alarm	Red	Red

4. Provide the following additional alarm outputs with Form C contacts (normally closed, open on alarm). The contacts shall be connected to a terminal strip in an enclosure set adjacent to the generator. Coordinate these and other alarms with controls contractor for annunciation to required building systems. Provide 10 spare pairs of terminal blocks:

    a. Standby engine run
    b. Standby engine failure (To originate from the alarm annunciator)
    c. Standby engine start system failure (To originate from the alarm annunciator)
    d. Low fuel main tank

e. Low fuel day tank

E. Provide auxiliary engine run contacts for control of auxiliary systems required for operation of engine, such as ventilation, fuel system, electric start, regulator, governor, remote mounted fan, etc. Provide normally closed contacts for operation of intake and exhaust air dampers. In addition, provide a minimum of four (4) spare SPDT contacts.

2.12 GENERATOR CIRCUIT BREAKER:

A. Provide output main line circuit breaker which shall operate both manually as an isolation switch and automatically during overload and short circuit conditions.

B. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by UL, NEMA and the NEC.

Generator breakers shall be molded-case, solid-state trip, rated for the appropriate voltage and symmetrical interrupting capacity. Provide adjustable solid-state/digital long-time-delay (LTD), short-time-delay (STD), ground fault (GRD), and instantaneous (INST) trip elements with each breaker. Pickup/delay adjustments and ranges associated with these trips will be as follows: LTD pickup - (0.5-1.0) x sensor, four time delay bands; STD pickup - (2-9) x LTD pickup, three time bands (0.1-0.35) second with I^2t ramp; (GRD) pickup - (0.2-0.6) x sensor, three time bands (0.1-0.35) second with I^2t ramp; INST pickup - (2-10) x sensor. Ground fault trip may be omitted when ground fault alarm is provided by a time overcurrent relay across the generator neutral current transformer. Provide trip indicators to show “overload”, “short-circuit”, and “ground-fault” trip.

C. Provide generator circuit breaker in a NEMA 1 enclosure adjacent to the generator terminal compartment. Provide sufficient space for conduit and cable termination in and around the circuit breaker enclosure. Generator output shall be cabled at the factory or on site by the generator manufacturer.

D. Provide circuit breaker with auxiliary contacts which provide contact closure upon breaker automatic trip or manual opening. The alarm contact is to be used for remote annunciation of circuit breaker tripped or open.

E. Circuit Breaker shall be 100% rated for continuous loads.

2.13 STATE OF ASSEMBLY:

A. The engine generator system shall be factory assembled. Clean and paint all components per manufacturer's standards or as noted otherwise. Indoor and Outdoor Enclosures and Components shall be powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Paint manufacturer’s standard color or as directed by Architect/Engineer.

B. Accessory items shall be mounted directly on engine generator skid except where freestanding or remotely mounted. Provide all wiring and conduit including: power wiring, lighting, receptacles, alarms, etc., for a fully installed system and include termination points/blocks for all remote or freestanding items.

1. Provide for and coordinate all field installed conduit and wiring between generator and remote or freestanding items. Provide all breakers, enclosures, lugs, labeled terminal strips, etc.,, for a complete installation.

C. Nameplates: Provide nameplate for each major system component to identify manufacturer's name and address, model, serial number of component. Include information of the power output rating of the equipment.

2.14 EXTRA MATERIALS:

A. Provide spare parts for one year's maintenance of the engine generator system. Parts shall be labeled with the equipment identification which they are associated with and packed for storage. Spare parts shall include but not be limited to:

1. Belts: Provide 2 of each type.
2. Hoses: Provide 2 of each type.
3. Fuses: for voltage regulator and controls: Provide 3 of each type.
4. Filters: Provide 2 of each type, (fuel, air, water, oil, etc.)
5. Lamps/LED's: Provide 2 of each type.

2.15 SOUND ATTENUATING WEATHERPROOF HOUSING:

A. General: Provide a complete and operational generator enclosure, including all devices and equipment specified herein, as shown on the drawings and as required for service. Enclosure shall be factory installed and allow lifting of complete assembly as a single unit.

B. The enclosure shall conform with local building codes for the specified location and to withstand the highest level of winds as listed by the ANSI Basic Wind Speed Map for the contiguous United States.

C. Reach-In type: Enclosure shall be reach-in type and factory standard option. Submit proposed factory detail drawings that fully identify enclosure construction, clearances, and access. Enclosure shall be constructed of all welded, formed sheet steel or bolted with sealed seams.

1. Construction shall allow for ability of panel replacement as well as engine/generator repairs to be performed without complete enclosure removal.
2. Provide LED lighting: 2 internal engine voltage DC lights and 2 control panel DC lights. Provide 0-30 min. wind up timer switches for internal lights and control panel lights.

D. The entire enclosure shall be finished as follows:

1. The enclosure shall be hot steam or pressure cleaned, sanded and prepared to remove oils and debris.
2. Metal surfaces and all seams shall be sealed with a high quality sealant.
3. The enclosure shall be primed, coated, and finished with high grade automotive acrylic enamel.
4. Coordinate with Architect/Engineer and submit final color selection.

E. Provide sound attenuation on all four sides and top of enclosure to 75 dbA at 25 feet per owner and local code requirements.

F. Enclosure Accessories:

1. Provide exhaust silencer mounting bands and brackets for internal silencer.
2. Provide floor mounted battery racks.
3. Provide wall mounted battery charger.

4. Provide 4-LED lights and switch on 120 VAC source.
5. Provide LED lighting: 2 internal engine voltage DC lights and 2 control panel DC lights. Provide 0-30 min. wind up timer switches for internal lights and control panel lights.
6. Extend coolant and oil drains to outside of enclosure.
7. Extend fuel tank vents through roof of enclosure.

PART 3 - EXECUTION:

3.1 EXAMINATION:

A. Examine areas and conditions under which diesel engine-driven generator units are to be installed and notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer. Verify equipment furnished maintains all code, operation, and maintenance clearances.

3.2 INSTALLATION OF DIESEL ENGINE-DRIVEN GENERATOR SETS:

A. Install diesel engine-driven generator units in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator sets and accessories.

B. Coordinate with other work, including raceways, electrical boxes and fittings, fuel tanks, piping and accessories, wiring (including all interconnecting wiring between all major equipment, sections, etc., as necessary to interface installation of engine-generator equipment work with other work.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A, B and the National Electrical Code.

D. Install units on vibration isolators in accordance with manufacturer's indicated method of installation.

E. Connect fuel oil piping to generator equipment as indicated, and comply with manufacturer's installation instructions.

F. In addition to a section of flexible conduit, provide pull box or connection box large enough to partially coil output conductors from the generator or the generator mounted circuit breaker or at a minimum one bend in conduit to allow for three dimensional movement and vibration during startup, shutdown, changes in load, fault conditions, etc.

G. Provide strain relief to all: control, accessory, and annunciator wiring. Use stranded wiring and a section of flexible conduit.

3.3 GROUNDING:

A. Provide equipment grounding connections for diesel engine- driven generator units as indicated. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL:

A. Start-up Testing: Engage local equipment manufacturer's representative to perform start-up and load tests upon completion of installation, with the Engineer in attendance; provide certified test record.

B. The Contractor shall provide qualified personnel, load bank, cables, test equipment, fuel, and all other necessary materials required and perform the following tests:

1. Check fuel, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.
2. Test accessories that normally function while the set is in a standby mode for proper operation, prior to cranking engine. Accessories include but are not limited to: engine heaters, battery charger, generator strip heater, remote annunciator, alarms, etc.
3. Check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation during start-up test mode.
4. Test automatic start-up by remote-automatic starting, transfer of load, and automatic shutdown, by simulating a power outage. Prior to auto-start test, adjust transfer switch timers for proper system coordination. Test all modes of controlled start up/shut down. Monitor engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency throughout the test, in accordance with NFPA 110 requirements where applicable

5. Test the complete system using a resistive load bank to 1.0 P.F. If for any reason, the load test is terminated, the entire test shall be restarted until satisfactory results are obtained. Use the following test parameters:

    a. 2 hours at 50 percent rated load
    b. 2 hours at 100 percent rated load (NFPA)

6. During load bank tests, record the following data on 15 minute intervals:

    a. Generator kW
    b. Generator amps on each phase
    c. Generator volts on each phase and phase to neutral
    d. Generator frequency
    e. Jacket input water temperature
    f. Jacket output water temperature
    g. Lube oil pressure
    h. Lube oil temperature
    i. Fuel pressure
    j. Exhaust back-pressure
    k. Ambient temperature
    l. Radiator inlet air temperature
    m. Oil, coolant or fuel leakage
    n. Generator stator temperature
    o. Battery charge rate (at 5 minute intervals for first 15 minutes then 15 minute intervals thereafter.

7. Provide additional data for the following:

    a. Time to recover stable rated frequency and voltage after step addition of 50 percent, 75 percent AND 100 percent rated load.
    b. Voltage dip when applying the above step loads.

C. Upon completion of installation, demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and any retesting shall be included at no additional cost.

3.5 ADJUSTING:

A. Adjust battery charger output.

B. Adjust generator output voltage and engine speed.

3.6 CLEANING:

A. Clean engine and generator surfaces. Replace oil and fuel filters.

3.7 DEMONSTRATIONS:

A. Generator supplier shall provide Owner with a minimum of (4) hours field training and instruction.

B. Describe system operation under emergency conditions and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

D. Field training and instruction shall be videotaped and electronic copy shall be turned over to maintenance personnel on an approved Digital Storage Device.

3.8 OPERATION AND MAINTENANCE:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

1. Emergency instructions including addresses and telephone numbers for service sources.
2. Troubleshooting guidelines.
3. Complete operating instructions. All operating instructions shall include the following information as a minimum:

    a. Manufacturer's operating instructions for each piece of equipment furnished.
    b. Specific operating instructions for each portion of the system which involves multiple items of equipment.
    c. Instructions for charging, start-up, control or sequencing of operation, phase or seasonal variations, shut-down, safety and similar operations.

4. Recommended maintenance procedures and intervals for all equipment.
5. Complete shop drawings related to the entire system.
6. Technical data sheets for all equipment.
7. Complete interconnection diagrams which indicate all components of the system, including control systems and alarm interface.
8. Manufacturer's maintenance data including complete parts lists, partial detailed parts drawings, etc. for each operational item in each system.

9. Ordering information for spare parts.
10. Manufacturer's product warranties and guarantee relating to the system and equipment items in the system.

B. Provide the following additional operating documents:

1. A safety shutdown list provided on the generator set and in the generator maintenance manual. Verify that the appropriate safety controls have been provided based on the shutdown list.
2. Satisfactory engine/alternator test records, lubrication, fuel and start battery maintenance records with space for continued entries.
3. "Engine operating instructions" posted near the unit that provides clearly defined, step-by-step procedures for starting, running and stopping the engine.
4. Lockout-tagout procedures in place for the AC switchgear and distribution during normal operation, manual operation and testing.

3.9 WARRANTY:

A. Provide manufacturer's warranty for duration of not less than two (2) years from the date of substantial completion of the project. The warranty shall include, but not be limited to, the replacement of materials and equipment used in diesel generator systems.

B. Extended Warranty Agreement: Offer terms and conditions for furnishing parts and providing continued testing and servicing, beyond the warranty period, including replacement of materials and equipment, for a one-year period with an option for renewal of the Agreement by the Owner.

C. Maintenance Agreement: Prior to time of final acceptance, the supplier shall submit 4 copies of an agreement for continued service and maintenance of the diesel engine-driven generator sets, for the Owner's review and possible acceptance.

END OF SECTION 26 32 13

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SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes transfer switches rated 600 V and less. It includes the following items:

1. Automatic transfer switch (ATS).
2. Non-automatic transfer switch (NATS).
3. Remote annunciation and control system.

1.2 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product data and shop drawings for each transfer switch, including dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and materials lists.

C. Checklist: Submit a detailed checklist which acknowledges compliance or a reason for non-compliance to each of the specification requirements. Arrange the checklist according to the headings of each item identified in this specification (i.e. shop drawings, wiring diagrams individual line items, etc.). Mark items as “N/A” where the item is not applicable.

D. Wiring diagrams, elementary or schematic, differentiating between manufacturer-installed and field-installed wiring.

E. Single-line diagrams of transfer switch units showing connections between automatic transfer switch, bypass/isolation switch, power source, and load, plus interlocking provisions.

F. Maintenance Data: Submit operation and maintenance data, schedule of recommended service and parts lists for materials and products. Include this data, product data, shop drawings, record drawings, and wiring diagrams in maintenance manual in accordance with requirements of applicable Division 26 Sections and Division 1. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay setting and calibration instructions.

G. Manufacturer's certificate of compliance to the referenced standards and tested short-circuit closing and withstand ratings applicable to the protective devices and current ratings used.

H. Submit ATS and associated circuit breaker coordination curves that show UL 1008 compliance.

I. AHJ Approval: Provide certificate or other evidence that the Authority Having Jurisdiction will accept the proposed installation for closed transition transfer switches.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electrical power transfer switches, of types, ratings, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing electrical power transfer switches similar to that required for this project.

C. Emergency Service: Manufacturer with a service center capable of providing emergency maintenance and repairs at the Project site with an 8-hour maximum response time.

D. Comply with NEMA Standard ICS-2-447-AC Automatic Transfer Switches.

E. UL Listing and Labeling: Items furnished under this Section shall be listed and labeled by UL for Emergency Service under UL Standard 1008.

F. National Recognized Testing Laboratory Listing (NRTL) and Labeling: Items furnished under this Section shall be listed and labeled by a NRTL for emergency service under UL Standard 1008.

1. Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

G. Single-Source Responsibility: Obtain ATSs, BP/ISs, remote annunciators, and remote annunciator and control panels from a single manufacturer that assumes responsibility for all system components furnished.

H. Source Quality Control: Factory test components, assembled switches, and associated equipment to ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for conformance with specified requirements. Perform dielectric strength test conforming to NEMA ICS 1.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Deliver transfer switches and associated devices in factory-fabricated type containers or wrappings, which properly protect equipment from damage.

B. Store transfer switches and associated devices in original packaging, and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle transfer switches and associated devices carefully to prevent physical damage to equipment. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Zenith Controls, Inc.
2. Automatic Switch Company. (ASCO)
3. Cummins/Onan (When associated with Onan generator only)
4. Caterpillar, Inc. (When associated with Caterpillar generator only)
5. Russelectric, Inc.

2.2 TRANSFER SWITCH PRODUCTS, GENERAL:

A. Number of Poles and Current and Voltage Ratings: As indicated

1. Units smaller than 400 amperes shall not have different current ratings for different classes or mixtures of loads, including 100 percent tungsten filament lamp or 100 percent inductive load.
2. Units 400 amperes and larger shall have current ratings that apply to mixtures of loads including 30-percent-maximum tungsten filament lamp load.
3. The current rating shall be a continuous rating when the switch is installed in an unventilated enclosure and shall comply with NEMA temperature rise standards.

B. Tested Fault-Current Ratings: Closing and withstand ratings shall exceed the indicated available rms. symmetrical fault current at the equipment terminals based on testing according to UL Standard 1008, conducted at full-rated system voltage. For closed transition transfer switch, the fault current rating shall exceed that of the combined utility and generator in parallel. Rate each product for withstand duration time when tested for rated short-circuit current correlated with the actual type of circuit protective device indicated for transfer switches for this Project.

C. Annunciation and Control Interface Components: Provide devices at transfer switches for communicating with remote annunciators or annunciator/control panels which have communications capability matched with the remote device.

D. Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 degrees C. to 70 degrees C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage surge withstand capability requirements when tested according to ANSI C37.90.1, IEEE Guide for Surge Withstand Capability (SWC) Tests. Components meet or exceed voltage impulse withstand test of NEMA ICS 1.

F. Four-Pole Switches: Where 4-pole switches are indicated, provide full-capacity and neutral switching.

G. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated shall be double the nominal rating of switch.

H. Enclosures: Provide a general-purpose NEMA 1 enclosure, conforming to UL Standard 508, "Electrical Industrial Control Equipment," except as otherwise indicated.

I. Heater: Provide a heater within enclosure of units exposed to outdoor temperature and humidity conditions. Connect thermostat within enclosure to control heater.

J. Factory Wiring: Train and bundle factory wiring and identify consistently with shop drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated terminals accommodate field wiring.
2. Power Terminal Arrangement and Field Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Terminals: Pressure-type, suitable for copper or aluminum conductors of sizes indicated.
4. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Electrical Operation: Where indicated, accomplish by a non-fused, momentarily energized solenoid or electric motor-operated mechanism, mechanically and electrically interlocked in both directions. Switches using components of molded-case circuit breakers or contactors not designed for continuous-duty, repetitive switching between active power sources is not acceptable.

L. Switch Action: The switch contacts shall be mechanically held in both directions for double-throw switches.

M. Switch Contacts: Use silver composition for switching load current. Units rated 225 amperes and more shall have separate arcing contacts.

N. Overcurrent devices are not part of switch products.

O. Transfer switch shall use copper bus throughout.

P. Control power for transfer switches shall operate from either source as available and shall include a connection terminal for a third separate source of power. Control, indication alarms, etc. shall operate from any of these sources automatically.

Q. Provide two-hole compression lugs on all incoming and load side phase, neutral, and ground connectors.

2.3 AUTOMATIC TRANSFER SWITCHES (ATS):

A. Comply with Level 1 equipment according to NFPA 110, "Standard for Emergency and Standby Power Systems."

B. Manual Switch Operation: The switch shall have provision for manual operation under load with the door closed with either or both sources energized. Transfer time shall be the same as for electrical operation. Control circuit shall automatically disconnect from electrical operator during manual operation.

C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts shall operate in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

D. Digital Communications Interface: Provide full-duplex RS - 485/422/232 type, matched to capability of remote annunciator and control panel.

E. Switching Arrangement: Unless otherwise noted provide; Delayed (Programmed) Transition for Legally Required Standby System,

1. Delayed (Programmed) Transition: Switch Operator shall have a programmed neutral position arranged to provide a midpoint between the 2 working switch positions with an intentional, controlled, timed pause during transfer at the midpoint. The midpoint pause shall be adjustable from 0 to 60 seconds minimum, and factory set at 5 seconds, unless otherwise indicated. Time delay shall occur for both transfer directions.

2.4 AUTOMATIC TRANSFER SWITCH FEATURES:

A. Provide for normal source voltage sensing of each phase of normal source. Pick-up voltage shall be adjustable from 85 percent to 100 percent nominal, and drop-out voltage is adjustable from 75 percent to 98 percent pick-up value. Factory set for pick-up at 95 percent and drop-out at 85 percent.

B. Provide for emergency source voltage sensing of each phase to prevent premature transfer. Voltage pick-up shall be adjustable from 85 percent to 100 percent of nominal factory set to pick-up at 90 percent. Pick-up frequency shall be adjustable from 90 percent to 100 percent of nominal and factory set to pick-up at 98 percent.

C. Provide a transfer switch signal time delay to override normal source voltage-sensing, delay transfer signal and engine start signal. Delay shall be adjustable from 0 to 6 seconds, and factory set at 5 sec.

D. Provide a transfer to emergency time delay to delay transfer switch changeover after transfer signal. Delay shall be adjustable from 0 to 5 minutes and factory set at 0 minutes.

E. Provide a retransfer time delay including automatic defeat of the delay upon loss of voltage or sustained undervoltage of the emergency source, provided the normal supply has been restored. Delay shall be adjustable from 0 to 30 minutes and factory set at 15 minutes.

F. Provide an engine shut-down time delay adjustable from 0 to 15 minutes and factory set at 5 minutes.

G. Provide a momentary type test switch to simulate normal source failure.

H. Provide switch position pilot lights to indicate source to which the load is connected.

I. Provide source available indicating lights to supervise sources via the transfer switch normal and emergency source-sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

J. Provide a transfer override switch to override automatic retransfer control so the ATS will remain connected to the emergency power source regardless of the condition of the normal source. Provide a pilot light to indicate the override status.

K. Provide engine starting contacts, one isolated normally closed and one isolated normally open. Contacts shall be gold flashed or gold plated and rated 10 amperes at 32 V d.c. minimum.

L. Provide two normally open and two normally closed spare SPDT contacts for each switch position, rated 10 amps at 240 VAC.

M. Provide a solid-state programmable engine-generator exerciser time switch to start engine-generator set and transfer load to it from normal source for a preset time, then retransfer loads to normal source and shut down engine after a preset cool-down period. The exercise cycle shall be initiated at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes and factory-set for 7 days and 20 minutes respectively. Exerciser features include:

1. Exerciser transfer selector switch which permits selection between exercise with and without load transfer.
2. Push button programming controls with digital display of settings.
3. Integral battery operation of time switch when normal control power is not available.

N. Provide emergency power management data collection, processing, and software that automatically populate reporting of testing for all tests required in NFPA 110 and 99 as well as recording all other ATS operations including power outages, etc. Tests shall be manual or automatically initiated based on internal programmable scheduling. Sufficiently long power outages can automatically be used to eliminate additional testing for the current time period.

O. Interconnect BP/IS and ATS with copper bus bars plated at connection points and braced for the indicated available short circuit current.

2.5 NON-AUTOMATIC TRANSFER SWITCHES FEATURES:

A. Comply with applicable requirements of NFPA 100, "Standard for Emergency and Standby Power Systems."

B. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Provide a removable manual handle. Provide quick-make, quick-break switching action. The switch shall be capable of electrically or manually transferring the load in either direction, with 1 or both sources energized. The control circuit shall disconnect from the electrical operator during manual operation. Control shall ensure switch will not transfer to a dead source.

C. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence unless otherwise specified.

D. NATS Accessories

1. Provide pilot lights to indicate source to which the load is connected.
2. Provide source availability indicating lights which supervise sources via the transfer switch normal and alternate source sensing circuits, respectively.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."

3. Provide two sets of spare normally closed and normally open SPDT contacts for each switch position, rated 10 amperes at 240 VAC.
4. Provide double lugs at alternate source connection (one set for receptacle/tap box wiring and one set for possible hardwire connection) and adequate knockouts in enclosure for additional wiring.

2.6 REMOTE ANNUNCIATOR WITH CONTROLS :

A. Provide a remote annunciation and control panel which shall provide the functions listed below for each transfer switch unless otherwise indicated.

1. Sources-available indication (as defined by actual pick-up and drop-out settings of transfer switch controls).
2. Switch position indication.
3. Switch in test mode indication.
4. Failure of digital communications link indication.
5. Key switch or user code access to control functions of panel (Control Function).
6. Control of switch test initiation (Control Function).
7. Control of switch operation in either direction (Control Funtion).

8. Control of bypass of time delay for transfer to normal source (Control Function).
9. Malfunction of the annunciator unit or communication link shall not affect functions of the ATS. In the event of a failure of the communication link, the ATS automatically reverts to stand-alone, self-contained operation. No ATS sensing, controlling, or operating function depends on the remote panel for proper operation.

B. Remote Annunciator and Control Panel Features:

1. Description: Solid-state control and indicating panel. Group controls and indicating lights for each transfer switch together. Label each group indicating the transfer switch it controls, the location of that switch, and the load it serves.
2. Provide digital communications matched to that of the transfer switches to be supervised.
3. Provide surface mounted modular, steel cabinet except as indicated.

2.7 FINISHES

A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which transfer switches are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION OF AUTOMATIC TRANSFER SWITCHES:

A. Install transfer switches, including associated control devices as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that transfer switches comply with requirements. Comply with applicable requirements of NEC and NFPA pertaining to wiring practices and installation of electrical power transfer switches.

B. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of transfer switch work with other work.

C. Tighten factory-made connections, including connectors, terminals, bus joints, mountings, and grounding. Tighten field-connected connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values. When manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

3.3 WIRING TO REMOTE COMPONENTS:

A. Match the type and number of cables and conductors to the control and communications requirements of the transfer switches used. Increase raceway sizes at no additional cost to the Owner if necessary to accommodate required wiring.

3.4 GROUNDING:

A. Make equipment grounding connections for transfer switch units as indicated and as required by the NEC.

3.5 FIELD QUALITY CONTROL:

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise field tests.

B. Preliminary Tests: Perform electrical tests as recommended by the manufacturer and as follows:

1. Measure phase-to-phase and phase-to-ground insulation resistance levels with insulation resistance tester, including external annunciator and control circuits. Use test voltages and procedure recommended by the manufacturer. Meet manufacturer's specified minimum resistance.
2. Check for electrical continuity of circuits and for short circuits.

C. Field Tests: Give 7-day advance notice of the tests and perform tests in presence of Owner's representative.

D. Coordinate tests with tests of generator plant and run them concurrently.

E. Tests: As recommended by the manufacturer and as follows:

1. Contact Resistance Test: Measure resistance of power contacts for ATSs, and NATSs. Resolve values in excess of 500 micro-ohms and differences between adjacent poles exceeding 50 percent.
2. Ground Fault Tests: Coordinate with testing specified in Division 16 Section on Overcurrent Protective Devices to ensure sensors are properly selected and located to optimize ground-fault protection where power is being delivered from either source.

    a. Verify grounding points and sensor ratings and locations.
    b. Apply simulated fault current at the sensors and observe reaction of circuit interrupting devices.

3. Operational Tests: Demonstrate interlock, sequence, and operational function for each switch at least 3 times.

    a. Simulate power failures of normal source to ATSs and of emergency source with normal source available.
    b. Simulate low phase-to-ground voltage for each phase of normal source of ATSs.
    c. Verify time-delay settings and pick-up and drop-out voltages.
    d. Verify all control and relay devices operate properly in each sequence.

F. Test Failures: Correct deficiencies identified by tests and prepare for retest. Verify that equipment meets the specified requirements.

G. Reports: Maintain a written record of observations and tests. Report defective materials and workmanship and retest corrected items. Record adjustable relay settings and measure insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 DEMONSTRATION:

A. Training: Furnish the services of a factory-authorized service representative to instruct Owner's personnel in the operation, maintenance, and adjustment of transfer switches and related equipment. Provide a minimum of 4 hours of instruction scheduled 7 days in advance.

B. Post step-by-step procedures for each switch provided.

C. Provide instruction and review of data logging and reporting of tests performed during installation and training.

END OF SECTION 263600

SECTION 26 43 13 - SURGE PROTECTIVE DEVICE (SPD)

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of SPD work is indicated by drawings and by requirements of this section.

B. These specifications describe the electrical and mechanical requirements for a high-energy surge protective device (SPD). The specified system shall provide effective, high-energy surge current diversion and be suitable for use as type 1 or Type 2, min. 20kA device per ANSI/UL 1449 Fourth edition.

C. The system shall be constructed using multiple surge-current diversion thermally protected metal oxide varistors (TPMOV). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

D. The specified system shall be designed, manufactured, tested and installed in compliance with the latest Edition following codes and standards:

1. Underwriters laboratories; ANSI/UL 1449 4th Edition
2. UL1283
3. UL96A
4. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.34, C62.41, C62.45)
5. Institute of Electrical and Electronic Engineers 1100 Emerald Book
6. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
7. National Fire Protection Association (NFPA 20, 70, 75 and 780)
8. International Standards Organization (ISO) Company certified ISO 9001 for manufacturing, design and service

E. The system shall be UL listed and labeled under ANSI/UL 1449 Fourth Edition and the Voltage Protection Ratings (VPRs) shall be permanently affixed to the SPD. Type 2 units of the product family shall also be Canadian underwriters laboratories (cUL) listed and labeled.

1.2 QUALITY ASSURANCE:

A. Manufacturers: firms regularly engaged in manufacture of SPD equipment of types, ratings, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's qualifications: firm with at least 5 years of successful installation experience with projects utilizing rectifier and invertor work similar to that required for this project.

C. The specified system shall be factory-tested before shipment. Testing of each system shall include but shall not be limited to quality control checks, "hi-pot" tests at twice rated voltage plus 1000 volts per UL requirements, IEEE c62.41 category b surge tests, UL ground leakage test, and operation and calibration tests.

D. The SPD shall have been duty life cycle tested following suggested wait times as defined by ANSI/IEEE C62.41and shall be capable of surviving 500 sequential category C surges of 10,000 amps without failure.

E. The system shall be UL listed as a complete system under the currently adopted UL 1449 standard for surge protective device (SPD) and the rating shall be permanently affixed to the SPD.

1.3 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Shop drawings: submit drawings of SPD equipment indicating unit dimensions, weights, component and connection locations, mounting provisions, connection details and wiring diagrams.

C. Test reports: documentation of specified system's UL 1449 listing, life cycle testing, overcurrent protection, noise attenuation, surge current capacity, and clamping voltage ratings shall be provided. This shall include computer generated graphs and oscillograms. Tests shall follow procedures outlined in ANSI/IEEE for installation category and applicable protection modes of SPD.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver SPD equipment and accessories individually packaged in factory-fabricated containers. Mount units on shipping skids.

B. Handle equipment carefully to prevent internal component damage, impact, breakage, denting, and scoring enclosure finishes. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

C. Store equipment in clean dry space, protect units from dirt, fumes, water, construction debris and traffic.

1.5 WARRANTY:

A. The manufacturer shall provide a full five year warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national or local electrical codes.

PART 2 - - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: subject to compliance with requirements, provide SPD products of the following:

1. Current technology
2. GE/liebert
3. Siemens

2.2 SYSTEM DESCRIPTION:

A. Environmental Requirements:

1. Storage Temperature: -67 °F to +185 °F (-55 °C to +85 °C).
2. Operating Temperature: -40 °F to +122 °F (-40 °C to +50 °C).
3. Relative Humidity: Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
4. Audible Noise: The audible noise level of the specified system shall be less than 45 dBA at 5 feet.
5. Operating Altitude: The system shall be capable of operating up to an altitude of 12,000 feet above sea level.
6. Magnetic Fields: Unit shall not generate appreciable magnetic field, and shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.

B. Electrical Requirements:

1. System Operation Voltage: The nominal system operating voltage shall be 277/480V and 120/208V WYE, 4 wire plus ground, or as indicated on drawings.
2. Maximum Continuous Operating Voltage (MCOV): The SPD maximum continuous operating voltage shall not be less than 115 percent of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage conditions. Each system shall be factory tested at the MCOV for at least one (1) hour.
3. Operating Frequency: The operating frequency range of the system shall be at least 47 to 63 Hertz.
4. Protection Modes: The SPD shall provide protection as follows:

    a. Line to line (Delta Configured System)
    b. Line to ground
    c. Neutral to ground (Wye Configured System)
    d. Line to neutral (Wye Configured System)

C. Performance Ratings: Provide SPD surge current capacity based on an 1.2x50 mircrosecond 20KV open circuit voltage, 8x20 microsecond short circuit current Category C3 Bi-wave per current Edition ANSI/IEEE C62.41and C62.45 standards as follows: (A balanced surge current capacity shall also be applied Neutral to Ground and Line to Neutral where neutrals are present in the system).

Service Entrance	
Per Phase	300 kAmps
Line to Neutral	150 kAmps
Line to Ground	150 kAmps
Line to Line	150 kAmps

Subdistribution	
Per Phase	300 kAmps
Line to Neutral	150 kAmps
Line to Ground	150 kAmps
Line to Line	150 kAmps

Panelboards	
Per Phase	120 kAmps
Line to Neutral	60 kAmps
Line to Ground	60 kAmps
Line to Line	60 kAmps

2.3 SPD EQUIPMENT:

A. Components: The system shall be a symmetrically balanced, metal oxide varistor (MOV) array system, constructed using surge current diversion modules. Each module shall be capable of withstanding over 1000 pulses of the 10 kAmps IEEE C62.41 Category C surge current without degradation of clamping voltage. The module shall consist of multiple gap-less metal oxide varistors, with each MOV individually fused. The modules shall be designed and constructed in a manner which ensures reasonable MOV surge current sharing. No gas tubes or silicon avalanche diodes shall be used. The status of each varistor shall be monitored and green LED shall be illuminated if the module is in full working order. When module performance is degraded, such as if one or more fuses or varistors have failed, the LED shall indicate a failed module.

B. High Frequency Tracking Filter: The unit shall include a UL 1238 high-frequency extended range tracking filter. The filter shall provide for high frequency transient filtering of up to 40 dB attenuation (per 50 Ohm Insertion Loss Methodology from MIL-STD E220A) for the band width extending from 10 KHZ to 100 MHZ. This filtering must remove low level surges and sharp wavefronts associated with fast rise-time transients, thus eliminating disturbances which may lead to "system upset".

C. Connections: Terminals shall be provided for all of the necessary power and ground connections. The terminals shall accommodate wire sizes of #14 to #2/0 AWG for two conductors per required connection. The units shall use standard parallel wiring techniques.

D. Internal Connections: All surge current diversion module intra-unit connections shall be by way of low impedance busbars or wiring. Surge current diversion modules shall use low impedance connections. All module mounting hardware and power wiring shall be captive or remain in place when a module is removed or replaced.

E. Enclosure: The specified system shall be provided in NEMA type appropriate to installation conditions. When provided the cover of the enclosure shall be hinged and require a tool for access to internal components. A drawing pocket shall be provided inside the door for storage of unit drawings and installation/operation manual. Indication of surge current module status shall be visible without opening the door.

F. Integral Test Point: The unit shall incorporate an integral test point allowing easy off-line diagnostic testing which verifies the operational integrity of the unit's suppression/filter system.

2.4 OVERCURRENT PROTECTION:

A. Fusing: all suppression components shall be thermally protected and rated to allow maximum specified surge current capacity. Devices that utilize a single fuse to protect two or more suppression paths are not accepted. Individual surge components shall be UL listed to be capable of interrupting up to 200 kA symmetrical fault current with 480 VAC applied.

Replaceable fusing is unacceptable. Overcurrent protection that limits specified surge currents is not acceptable.

2.5 ACCESSORIES:

A. LED indicators shall be provided on the hinged front cover to redundantly indicate unit module status. Additionally, a Form C (one N.O. and one N.C.) summary alarm contact rated for at least 120 VAC and 1 ampere shall be provided for remote annunciation of unit status. The summary alarm contact shall change state if any one or more of the surge current diversion modules has failed.

B. SPD must have an SCCR rating above the available fault current.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Installer must examine areas and conditions under which SPD equipment is to be installed, and notify contractor in writing of those conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION OF SPD EQUIPMENT:

A. Install SPD as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that SPD installation complies with requirements of NEMA standards and NEC, and applicable portions of NECA’s "standard of installation," for installation of units.

B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of SPD with other work.

C. Install electrical protective devices, if any, for each SPD unit.

D. The installing contractor shall install the parallel SPD with short and straight conductors as practically as possible. The contractor shall twist the SPD input conductors together to reduce input conductor inductance.

E. Field installation: the unit shall be installed as close as practical to the facility's wiring system in accordance with applicable national/local electrical codes and the manufacturer's recommended installation instructions. Connection shall be with #2 AWG copper conductor or larger and not be any longer than necessary, avoiding unnecessary bends. Notify engineer prior to installation if unit cannot be installed directly to bus or lead length within 18-24 inches or within manufacturer's required distances, whichever is shorter.

F. Manufacturer shall make available (local, national) field engineering service support. Where direct factory employed service engineers are not locally available, travel time from the factory or nearest dispatch center shall be included if necessary.

3.3 ADJUSTING AND CLEANING:

A. Touch-up scratched and marred surfaces of equipment to match original finishes; remove dirt and construction debris.

3.4 FIELD QUALITY CONTROL:

A. Upon completion of installation of SPD equipment and after circuitry has been energized with rated power source. Verify that the equipment is operating properly. Where possible, correct malfunctioning units at site; otherwise remove and replace with new units and re-verify operation.

END OF SECTION 26 43 13

SECTION 26 50 00 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY:

A. Extent, location, and details of lighting work are indicated on drawings and in schedules.

B. Types of lighting in this section include the following:

1. Light Emitting Diode (LED)

1.2 SUBMITTALS:

A. See Section 260500 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Shop Drawings: Submit layout drawings of lighting and their spatial relationship to each other. In addition, submit luminaire cut sheets from the manufacturer. For standard products submit shop drawings; for non-standard products submit in booklet form with separate sheet for each luminaire, assembled by "luminaire type" with proposed luminaire and accessories clearly indicated on each sheet. Submit details indicating compatibility with ceiling grid system. Shop drawings shall detail luminaire dimensions, weights, methods of field assembly, mounting components, features and accessories. All features and accessories shall be clearly defined.

C. Wiring Diagrams: Submit wiring diagrams for lighting showing connections to electrical power panels, switches, dimmers, controllers, and feeders. Differentiate between portions of wiring which are manufacturer-installed and portions which are field- installed.

D. Samples: Submit one complete operating unit for each type of custom luminaire specified.

E. Illumination Data: Submit lighting calculations identified below for all products not listed first in the luminaire schedule and where otherwise noted.

1. Interior: Provide isofootcandle (isolux) plot diagram of footcandles on horizontal workplane surface which shows composite values of illuminance projected from the arrangement of light sources from indicated luminaire locations and heights. Show on the graphic plots the locations, spacing’s and heights of luminaires. Indicate values of maximum, average, minimum, max/min ratios, and Lumen Maintenance factor utilized.
2. Exterior: Provide isofootcandle (isolux) plot diagram of footcandles on horizontal pavement surface which shows composite values of illuminance projected from the arrangement of light sources from indicated luminaire locations and heights. Show on the graphic plots the locations, spacing’s, heights of luminaires, and the Lumen Maintenance factor used.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lighting of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with lighting work similar to that required for this project.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Deliver lighting in factory-fabricated containers or wrappings, which properly protect luminaires from damage.

B. Store lighting in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off ground.

C. Handle lighting carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.5 SEQUENCING AND SCHEDULING:

A. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of lighting with other work.

B. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

1.6 EXTRA MATERIALS:

A. LED Modules: Furnish replacement modules amounting to 3% of each type.

B. Deliver replacement stock as directed to Owner's storage space.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Luminaire Manufacturers: Subject to compliance with requirements, provide luminaires as listed in the luminaire schedule or elsewhere on the drawings or specification.

B. LED Manufactures:

1. Philips Lighting Co.
2. Lumiled
3. CREE
4. Nichia
5. Osram Sylvania

C. All other manufacturers shall request prior approval and supply test data from an independent testing laboratory and comparison report to substantiate compliance with specifications and specified equipment.

2.2 EQUIPMENT:

A. General: Provide lighting of sizes, types and ratings indicated; complete with, but not limited to, housings, energy-efficient lamps, lamp holders, reflectors, energy efficient ballasts, starters and wiring. Ship luminaires factory-assembled, with those components required for a complete installation. Design luminaire with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen ballast generated noise and as to disconnect ballast when door is opened for HQI lamps.

B. Lamps:

1. Provide LED's that retain 70% of lamp life after 50,000 hours. LED's shall be binned to NEMA standard SSL 3-2010. *Indoor luminaires shall have remote phosphors. The LED light assembly shall be replaceable separate from the luminaire housing. The LED driver shall be dimming where indicated on the drawings. The dimmer switch shall be compatible with the driver, unless otherwise noted.*

    a. *Indoor luminaires shall have remote phosphor technology for "white" LED's.
    b. *All LED products and information to be in accordance with IES Standards LM79 & LM80.

2. Provide all lamps with CRI 85 or higher unless otherwise indicated. It is important that color fidelity (color rendering aspects of lamp sources) and color appearance (the consistent appearance of the light source) are provided for all lamps.

C. All lenses listed as .125" minimum shall be 9.1 oz/sq ft.

D. LED Drivers: THD less than 10%. All 0-10V drivers shall be provided with isolation on the secondary analog side to eliminate secondary voltage on the 0-10V channel.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which lighting is to be installed, and substrate for supporting lighting. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

A. Install lighting at locations and heights as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fulfills requirements.

B. Provide luminaires and/or outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Architect.

1. Luminaires shall be positively attached to the suspended ceiling system. The attachment device shall have a capacity of 100% of the luminaire weight acting in any direction.
2. When intermediate systems are used, No. 12 gauge hangers shall be attached to the grid members within 3" of each corner of each luminaire.
3. When heavy-duty systems are used, supplemental hangers are not required if a 48" modular hanger pattern is followed. When cross runners are used without supplemental hangers to support luminaires, these cross runners shall provide the same carrying capacity as the main runner.
4. Luminaires weighing less than 56 pounds shall have, in addition to the requirements above, two No. 12 gauge hangers connected from the luminaire housing to the structure above. These wires may be slack.
5. Luminaires weighing 56 pounds or more shall be supported directly from the structure above by four No. 12 gauge hangers connected from the luminaire housing to the structure above. These wires may be slack.

C. Install flush mounted luminaires properly to eliminate light leakage between frame and finished surface.

D. Provide plaster frames for recessed luminaires installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.

E. Fasten luminaires securely to structural supports; and ensure that pendant luminaires are plumb and level. Provide individually mounted pendant luminaires longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum one inch vertical adjustment. Mount continuous rows of luminaires with an additional stem hanger greater than number of luminaires in the row.

1. Pendant hung luminaires shall be supported directly from the structure above with No. 9 gauge wire or approved alternate support without using the ceiling suspension system for direct support.
2. Luminaires mounted in areas of high seismic activity shall be mounted from a rigid stem to restrain sway. If mounted from a non-rigid stem, luminaires to be mounted such that their sway under seismic conditions does not impact another luminaire within 45˚ swing from nadir.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.

G. Support surface mounted luminaires greater than 2 feet in length at a point in addition to the outlet box stud.

H. Set units plumb, square, level and secure according to manufacturer’s written instructions and shop drawings. Refer to specification section 265613, “Poles and Standards” for other requirements.

3.3 FIELD QUALITY CONTROL:

A. Replace defective and burned out lamps for a period of one year following the Date of Substantial Completion.

B. Refer to Division-1 sections for the replacement/ restoration of lamps in lighting where used for temporary lighting prior to Date of Substantial Completion.

3.4 ADJUSTING AND CLEANING:

A. Clean lighting of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses and reflectors.

B. Protect installed luminaires from damage during remainder of construction period.

C. Adjust aimable luminaires to provide required light intensities and in compliance with design intent.

3.5 GROUNDING:

A. Provide equipment grounding connections for lighting as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

B. Ground luminaires according to Section 260526, "Grounding," and Section 265613, "Poles and Standards."

3.6 WARRANTY

A. The Contractor shall guarantee all equipment including ballasts, lamps, luminaires, wiring, etc. free from inherent mechanical and electrical defects. Warranty period shall be from date of acceptance as set forth in the general conditions with periods as follows:

1. Luminaires, wiring, etc. - 1 year
2. LED and Driver – Five year manufacturer’s warranty.

3.7 DEMONSTRATION:

A. Upon completion of installation of lighting and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION 26 50 00

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SECTION 26 56 13 - LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of lighting poles and standards work is indicated by drawings and schedules.

B. Applications of lighting poles and standards for this project include the following:

1. Private roadways
2. Automobile parking lots
3. Building entrances

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical poles and standards of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical pole and standard work similar to that required for this project.

1.3 DELIVERY, STORAGE AND HANDLING:

A. Store poles on decay-resistant treated skids at least 1 foot above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.

1. Fiber Glass Poles: Retain factory-applied pole wrappings until just before pole installation. Handle poles with web fabric straps.
2. Metal Poles: Retain factory-applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.4 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product Data: Submit manufacturer's data on electrical poles, standards and hardware; include certified dimension drawings for fabricated poles, standards and mast arms, if any.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of pole or standard).

1. Metal Poles:

a. Anchor Metals, Inc.
b. Marathon Steel Co.
c. Meyer Industries Div; ITT Corp.
d. Union Metal Mfg Co.

e. Valmont Industries, Inc.

2. Pole Hardware:

a. A.B. Chance Co.
b. Dixie Electrical Mfg Co.
c. Stanley G. Flagg and Co., Inc.
d. Hercules, Inc.
e. Joslyn Mfg and Supply Co.
f. McGraw-Edison Co.
g. Preform Line Products Co.
h. Reliable Electric Co.
i. Utilities Service Co.

2.2 POLES AND STANDARDS:

A. Metal Lighting Standards: Provide metal, raceway-type, lighting poles and standards, of sizes and types indicated, comprised of shaft and bracket; equip with grounding connection readily accessible from handhole or transformer base access door; and construct of the following materials and additional construction features:

1. Material: Stainless steel.
2. Material: Galvanized steel.
3. Material: Spun aluminum.
4. Material: Extruded aluminum.
5. Material: Bronze.
6. Material: Cast iron.
7. Configuration: Embedded type base and reinforcing sleeve with hand and cable entrance holes where indicated.
8. Configuration: Anchor base type with hand hole and cover where indicated.
9. Configuration: Transformer base type with access door and cover.
10. Metal Lighting Standard Accessories: Provide accessories for metal lighting standards, including anchor bolts, as recommended by lighting standard manufacturer, of sizes and materials needed to meet erection and loading application requirements.

B. Metal Poles: Provide galvanized steel, tapered tubular seamless shaft poles, of sizes and types indicated, with 1/4inch bearing plates and ground sleeves for direct embedment. Provide removable step bolts 3/4 inch diameter and 6inches long with threaded steel lugs welded to pole beginning 12 inches above finish grade. Space step bolts at 15 inches intervals on alternative sides of pole continuing to the top. Provide pole with adequately sized reinforced handhole complete with matching cover and located on climbing side of pole, 18 inches above grade level. Weld 1/2 inch grounding nut on shaft with accessibility from handhole. Design poles to withstand loads developed by 100 MPH wind pressure, as adjusted for height above ground level, structural shapes and cable/wire loading. Construct poles whose total length is over 40 feet in two sections for shipping purposes.

1. Metal Pole Accessories: Provide accessories for metal poles, including cross-arms, bolts, lifting eyes, and nuts as recommended by pole manufacturer, of sizes and materials needed to meet erection and loading application requirements.

C. Lighting Brackets: Provide corrosion-resistant, metal brackets, cantilevered without under-brace, of sizes and styles indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF LIGHTING POLES AND STANDARDS:

A. Install lighting poles as indicated, in accordance with manufacturer's written instructions, in compliance with National Electrical Safety Code and NECA's "Standard of Installation" to ensure that poles comply with requirements.

B. To protect finishes, use belt slings or rope (not chain or cable) to raise and set finished poles.

C. Set poles and standards plumb. Support adequately when anchoring to foundations.

D. Provide sufficient space encompassing hand access and cable entrance holes for installation of cables from underground where indicated.

E. Provide Operating and Maintenance Instructions in electronic format covering all equipment furnished. Manuals shall include the following information:

1. Name, address and telephone number of authorized service organization to be contacted for each equipment item.
2. Parts list and wiring diagram, operating and maintenance instructions for each piece of equipment.
3. Record Set of Shop Drawings: Shop drawings corrected to show as-built conditions. Transfer modifications from field set.
4. All wiring diagrams shall show color coding of all connections and mounting dimensions of equipment.
5. Provide Testing and Equipment Settings Report for each device indicating final configurations and settings.

3.2 GROUNDING:

A. Provide equipment bonding and grounding connections, sufficiently tight to assure permanent and effective grounds, where indicated, for installed poles and standards.

1. Ground metallic components of lighting unit and foundations. Connect lighting to ground system with No. 6 AWG conductor.

3.3 FIELD QUALITY CONTROL:

A. Replace defective and burned out lamps for a period of one year following the Date of Substantial Completion.

3.4 ADJUSTING AND CLEANING:

A. Clean lighting of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses and reflectors.

B. Protect installed luminaires from damage during remainder of construction period.

C. Adjust aimable luminaires to provide required light intensities and in compliance with design intent.

END OF SECTION 265613

SECTION 27 05 00 – COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections.

B. Architectural, Electrical, Structural, Civil, Mechanical, Plumbing, Fire Protection, and Technology Drawings & Specifications. Other systems drawings may apply. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

1.2 SUMMARY

A. All work shall be conducted in coordination with Owner IT and other building trades.

B. The work covered by this section consists of furnishing all materials, accessories, connectors, supports, electrical protection, equipment, tools, setup, preparation, labor, supervision, incidentals, transportation, storage, and related items and appurtenances, and performing all operations necessary to complete the telecommunications work as indicated in the project drawings and specified herein. It is the intent and purpose of this specification to have, upon completion of the project, a “turn-key” telecommunications system designed, built, coordinated and integrated with the existing telecommunications system and complete and operable in all respects. Completely install, connect, and test all systems, equipment, devices, etc., shown or noted or required to final connections and leave ready for satisfactory operation. Provide any minor items omitted from the design, but obviously necessary to accomplish the above intent.

C. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:
   1. Factory Assembled Products
   2. Compatibility of Related Equipment
   3. Special Tools and Kits
   4. Firestops and Penetration Seals
   5. Anchoring and Supports
   6. Cutting and Patching
   7. Concealment
   8. Equipment Modification

1.3 GLOSSARY

A. ANSI - American National Standards Institute

B. ASHRAE - American Society of Heating and Air-Conditioning Engineers

C. ASTM - American Society for Testing and Materials

D. BICSI - Building Industry Consulting Services International

E. FCC - Federal Communications Commission

F. IEEE - Institute of Electrical and Electronics Engineers

G. ISO - International Organization for Standardization

H. Owner IT - Division of Information Technology

I. NEC - National Electrical Code

J. NEMA - National Electrical Manufacturers Association

K. NESC - National Electrical Safety Code

L. NFPA - National Fire Protection Association

M. OSHA - Occupational Safety and Health Administration

N. TIA - Telecommunications Industry Association

O. UFBC - Uniform Fire Prevention and Building Code

P. SIR - Service Interruption Request

Q. RCDD - Registered Communications Distribution Designer

R. UL - Underwriter's Laboratories, Inc.

1.4 BASIS OF BID

A. The Contractor shall verify all existing conditions affecting the work, the basis of construction to be used, and the nature and extent of work provided by other trades. Failure to do so shall be construed as acceptance of conditions and the Contractor assumes all liabilities hence forth.

B. The Contractor shall notify the Engineer/Owner a minimum of ten (10) days prior to the bid date in the event of any of the following circumstances:
1. Required items or details have been omitted from the Construction Documents and require additional monies to remedy.
2. Discrepancies or conflicts between the requirements of the Drawings and the Specifications, between the Governing Requirements and the Construction Documents.

C. Where omissions, discrepancies, or conflicts are not brought to the attention of the Engineer/Owner, it shall be assumed that the most stringent requirement(s) constitute the basis for the Contractor's bid, and as such shall be construed as intentional by the Contractor to provide complete and fully operational system(s) within the amount bid.

D. Fees for necessary or required licenses, permits, and inspections shall be included in the bid amount.

E. Methods of construction specified, shall be at the sole risk of the Contractor and as such are subject to rejection without consideration at the time of submittal review – should the Contractor be awarded the contract a submittal review will take precedence.

F. Bids shall be based on products, materials and means and methods of construction as specified. Bids based upon substitution of product and materials, as well as deviations from the bidder shall not sub-contract portions of the work

G. By submitting a Bid, the Contractor agrees:
1. To honor the Contractor's Bid for 90 days subsequent to the date that bids are opened.

2. To enter into and execute a Contract, if awarded, and to furnish all bonds and insurance required by the Contract Documents without exception.
3. To accomplish the Work in accordance with the Contract Documents and Specifications.
4. To complete the Work within the schedule stipulated by the Contract.
5. That the Owner reserves the right to:
    a. Adopt all or any part of the Bidder's proposal.
    b. Reject any or all bids received.
    c. Withhold the award of the Contract or otherwise choose to not award the Contract.
    d. Waive or decline to waive any informality or irregularities in any bid response received.
    e. Select the Bidder the Owner deems to be most qualified to fulfill the needs of the Project. The lowest cost proposal will not necessarily be the proposal deemed to be the most qualified – factors in addition to cost will be used to determine the most qualified proposal.

1.5 BID FORMAT

A. The Bid shall contain the following mandatory documentation. Bids submitted without this documentation (in whole or in part) may be rejected without review. The documentation shall be provided in addition to any forms/documents required by the General Provisions of the Contract and/or the contracting authority.
    1. Statement of Qualifications: Provide per Division 27 Specification Section *Contractor Qualifications* and/or its sub-sections.
    2. Bid Form: A bid form summarizing the Contractor's bid as required by the General Provisions of the Contract and/or the Contracting Authority.
    3. Bid Supplement: Complete the Bid Supplement attached to the end of this Section.
        a. The Bid Supplement shall be completed in addition to any forms/documentation required by the General Provisions of the Contract and/or the contracting authority.
    4. Additional Information:
        a. Bill of Materials (BOM): The BOM shall include each item individually priced, and shall reflect any and all required modifications, accessories, and labor for the item. Each item listed shall be complete with the following information:
            1) Description
            2) Part number
            3) Quantity included in bid
            4) Material cost
            5) Labor cost to install
            6) Total installation price
        b. Bid Bond: Provide documentation/certificate verifying same
        c. Performance Bond: Provide documentation/certificate verifying same

1.6 UNIT PRICING

A. Unit pricing is a price per unit of measurement for materials, equipment and/or labor added to or deducted from the Contract Sum by appropriate modification. Unit pricing is to be provided for common items which may be added or deleted during the course of construction.
    1. Unit prices shall include all costs of related coordination, modification, or adjustment of the Work to accommodate and completely integrate the component into the project, and shall include, but shall not be limited to, all necessary materials and labor.
    2. Unit pricing shall remain in effect until Final Acceptance.
    3. It is the intent that components added by unit price during construction shall result in complete and operable components ready for the Owner's use. It is further the intent that components deducted by unit pricing shall not adversely impact the remaining or adjacent work.

B. Provide unit prices for the addition/deduction. Unit pricing is broken out by the system(s) to which they pertain.

1.7 CONFORMANCE

A. All work and materials shall conform to and be installed, inspected, and tested in accordance with the governing rules and regulations of federal, state, and local government agencies.

B. Installations, materials, equipment and workmanship shall conform to the specifications and drawings and all applicable provisions of the most recent versions of the following regulations, codes, and standards including all applicable addenda:
1. NFPA 70 / NEC
2. NESC (IEEE)
3. NFPA 101 Life Safety Code
4. ASTM Standards
5. IEEE Standards
6. NEMA Standards
7. ANSI/TIA – Telecommunications Cabling Standards including, but not limited to current version of 568, 569, 598, 455 series, 472 series, 492 series, 526 series, 604 series, 606, and 758.
8. ICEA-S-83-596
9. FCC Code of Federal Regulations (CFR)
10. Applicable State of Colorado codes including UFBC and Department of Labor Rules and Regulations
11. Applicable Municipal codes
12. Applicable codes and regulations of other authorities having lawful jurisdiction pertaining to the work required
13. Americans with Disabilities Act (ADA)
14. Owner IT Standards
15. BICSI Telecommunications Distribution Methods Manual, Telecommunications Cabling Installation Manual, Customer-Owned Outside Plant Manual, LAN and Internetworking Design Manual, AV Design Reference Manual

C. All modifications required by the referenced codes, rules, regulations, and authorities shall be made by the Contractor without additional charge to Owner.

D. Report immediately to Owner IT personnel and/or the Consultant, in writing, any part of the telecommunication system design which does not conform to the requirements of these codes or regulations, or otherwise be held responsible to provide and install material which will comply with these codes and regulations.

E. Applicable codes and ordinances and local interpretations take precedence when they conflict with or are more stringent than the telecommunications design. Drawings and specifications take precedence where this design is more stringent than codes and ordinances.

F. All materials, appliances, equipment, and devices shall conform to the applicable standards of Underwriters Laboratories (UL), and shall be listed by UL if a UL listing category has been established. Furnish products that have been tested and qualified to meet the rating criteria by UL or other testing firm acceptable to authority having jurisdiction.

1.8 EMERGENCY FACILITIES

A. Maintain at all times free access to fire lanes and emergency and utility control facilities such as fire hydrants, fire alarm boxes, utility vaults, manholes, pull-boxes, etc.

B. Work shall not interfere with legal fire exits. Corridors, areas of egress, fire protection standpipes, hydrants, and exit stairs shall be maintained at all times.

1.9 SAFETY AND HEALTH REQUIREMENT

A. These construction documents and all phases of construction completed are to be governed by applicable provisions of the “Williams-Steiger Occupational Safety and Health Act of 1970, Public Law 91-596” and the latest amendments including, but not limited to:
   1. Reporting / Investigating Accidents
   2. Enforcement of a Program
   3. Telecommunications
   4. Hazard Communication
   5. Confined Space
   6. Lockout/Tagout
   7. Asbestos
   8. Assured Grounding
   9. Portable Wood Ladders
   10. Portable Metal Ladders
   11. Electrical Protection
   12. Exposure and Medical Records
   13. Emergency Evacuation
   14. Hantavirus/General Duty Clause / CDC Guidelines

B. Comply with Owner regulations and safety requirements, including, but not limited to, work in confined spaces, and mitigation of asbestos, lead, or other hazardous materials.

C. All applicable state, federal and local safety regulations shall be adhered to and all operations shall be conducted in a safe manner.

D. Contractor personnel working in hazardous areas shall have current training and applicable certification.

E. Provide hazards training certificates for all personnel working in hazardous areas.

F. Inspect work sites for hazards regularly.

G. Provide safety program documents as required for each project.

H. Comply with National Electrical Safety Code NESC including, but not limited to:
   1. Section 42,General Rules for Employees.
   2. Section 43, Additional Rules for Communications Employees.

I. Take all reasonable precautions for safety of, and provide reasonable protection to prevent damage, injury, or loss to:
   1. Personnel conducting project work and other persons who may be affected thereby; and
   2. Existing facilities, whether or not such facility is to be removed or relocated; and
   3. Project work and all materials and equipment to be incorporated therein, whether in storage or off site, under care, custody or control of Contractor or any subcontractors; and installed equipment and existing construction; and
   4. Other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, fences, roadways, structures and utilities not designed for removal, relocation or replacement in the course of construction.

J. Assume responsibility for construction safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety features required to provide safe conditions for all workers and site visitors.

K. Moderate public pedestrian traffic should be expected around all work locations. Ladders, scaffold, installation materials, and all other hazardous conditions must be fully protected at all times. Warning cones, barricades, warning tapes, etc. shall be used to warn and protect persons and property at all times in public corridors.

L. Comply with any and all code related and Owner specific safety requirements for work to be performed in confined spaces. The Owner requires appropriate safety training, physical examination and fit testing for employees working in confined spaces. This shall be provided to Contractor employees at the expense of the Contractor and at no cost to the Owner.

M. Comply fully with National Electrical Safety Code NESC and Owner specific safety requirements for work in electrical high voltage power manholes. Only licensed electricians may perform work in electrical high voltage power manholes. In addition, an Owner high voltage electrician escort is required to be on site throughout the time work is being conducted by contractors (including standing order electricians) in any high voltage power manholes or vaults.

1.10 SUBMITTALS

A. Product Data
   1. Provide manufacturer’s catalog information showing dimensions, colors, and configurations.
   2. Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:
      a. All fiber optic and balanced twisted pair cable: to include patch cords, cross connect wire and cross connect cordage.
      b. All connectors and required tooling.
      c. All termination system components for each cable type.
      d. All TR equipment frame types, hardware (and LAN equipment if applicable).
      e. All grounding and surge suppression system components.
      f. All test equipment to be used for fiber and balanced twisted pair channels.
   3. A Performance Specification showing manufacturer’s Guaranteed Channel Performance over the full swept frequency range.
   4. Technical data sheets shall include the physical specifications as well as the following electrical and transmission characteristics for balanced twisted pair channels:
      a. Mutual Capacitance
      b. Characteristic Impedance
      c. DC Resistance
      d. Insertion Loss (IL)
      e. Pair-to-Pair Near End Crosstalk (NEXT)
      f. Power Sum Near End Crosstalk (PSNEXT)
      g. ELFEXT (ELFEXT)
      h. Power Sum ELFEXT (PSELFEXT)
      i. Return Loss (RL)
      j. Propagation delay
      k. Delay Skew

B. Manufacturer’s Instructions
   1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.

2. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

C. Pre-Qualification Certificate
1. Contractor shall submit the following documents with project proposal:
a. A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
b. Training certificates for design, engineering and installation of the proposed products, for the relevant staff involved in the design and installation of this project.

D. Bid
1. Vendor shall submit complete detailed bids. Lump sum bids will not be accepted.

E. Material Guarantee
1. The wiring vendor (installer) shall guarantee at the time of the bid that all Category 6, Category 6A, and fiber optic cabling and components meet or exceed specifications (including installation) of TIA/EIA-568-C.1, 568-C.2, 568-C.3 and 569.

F. Material Provided
1. The successful wiring vendor (installer) shall be certain that all correct parts are ordered per Products Section of this document and installed in accordance with manufacturers design and installation guidelines. Vendor shall submit complete parts and part numbers to OWNER prior to installation of equipment.

G. Warranty Documentation
1. The entire data system including fiber optic cable shall have a manufacturer's warranty which guarantees that the cable and termination equipment shall be free from defects in material, workmanship and fabrication for a period of twenty years following the date of delivery of such products to the customer.
2. Complete documentation regarding the manufacturer’s warranty shall be submitted as part of the proposal. This shall include but is not limited to: a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.
3. A systems application assurance manual documenting the vendor supported applications and application guidelines shall be provided as part of the submittals.

1.11 DEFINITIONS

A. Every effort has been made to use industry standard terminology throughout this specification, but industry standard terminology is not used by all manufacturers and, in many cases, industry standard terminology does not exist. Contractor shall notify the Owner IT Project Manager (PM) and/or the Consultant to define terminology used in specifications if they believe any questions could arise.
1. Approved/Approval - Written permission to use a material or system
2. Consultant - Telecommunications Low-Voltage Consultant / Designer for Division 27 work for “Consultant Designed” projects, as defined in Section 27 00 00
3. Contractor - Telecommunications Contractor performing work under Division 27
4. Equal/Equivalent - Equally acceptable as determined by Owner IT
5. Final Acceptance - Owner acceptance of the project from Contractor
6. Furnish - Supply and deliver to installation location
7. Inspection - Visual observation at job site by Owner representative
8. Install - Mount and connect equipment and associated materials ready for use
9. Jack - Modular connector for station cabling medium (UTP copper, fiber, coax) at work-area outlet.

10. Outlet - Box and faceplate to accommodate up to six (6) modular jacks at the work-area.
11. Pull-Box - Box to be used for pull-through of cabling in a conduit run. Not to be used as a junction box.
12. Provide - Furnish and install complete with all details and ready for use
13. Relocate - Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use
14. Replace - Remove and provide new item
15. Telecommunications - All work specified in Division 27

B. Where this Division 27 indicates work to be performed by the words “shall” or “secure” or other performance functions, it shall be assumed that such work shall be performed by the telecommunications Contractor performing work under Division 27.

1.12 DRAWINGS AND SPECIFICATIONS

A. It is the intention of these specifications and related project drawings to call for finished work, tested and ready for operation in complete accordance with all applicable codes, regulations, standards, and ordinances.

B. These specifications and the project drawings are complimentary, and what is called for in either of these shall be binding as though called for by both. Should any conflict arise between the drawings and specifications, such conflict shall be brought to the attention of the Consultant and the Owner IT PM for resolution. If the Contractor fails to contact the Consultant and Owner IT PM in writing of any conflict between the specifications and the project drawings, the Contractor shall be subject to re-work the area of conflict at the Contractor’s cost.

C. Omissions from the specifications and/or project drawings or the incorrect description of details of work which are evidently necessary to carry out the intent of the specifications and project drawings, or which are customarily performed, shall not relieve the Contractor from performing such omitted or incorrectly described detail of the work. All work shall be performed as verified in field measurements, field construction criteria, material catalog numbers and similar data checked and coordinated with each shop drawing by the Contractor.

D. The telecommunications and technology project drawings are diagrammatic and indicate general design, layout, and arrangement of equipment and various systems. Being diagrammatic, the drawings may not necessarily show all details such as pull-boxes, conduit runs or sizes, etc., necessary for a complete and operable system. Unless detailed dimensioned drawings are included, exact locations are subject to approval of Owner.

E. Do not scale project drawings for dimensions. Take all dimensions and measurements from the site and actual equipment to be furnished. All dimensions, measurements, and the location and existence of underground equipment must be verified in the field since actual locations, distance, and elevations will be governed by actual field conditions. Contractor shall be responsible for all measurements taken from the field.

1.13 WORKMANSHIP, WARRANTY, AND SUPPORT

A. Materials and workmanship shall meet or exceed industry standards and be fully guaranteed for one full year from final acceptance for each project. Cable integrity and associated terminations shall be thoroughly inspected, fully tested and guaranteed as free from defects, transpositions, opens/shorts, tight kinks, damaged jacket insulation, etc.

B. Furnish a written warranty to Owner for a minimum of:

1. One-year materials warranty on parts and labor to repair/replace defective telecommunications materials specified herein. This warranty only applies to materials provided by Contractor and does not apply to materials provided by Owner.
2. Twenty-five-year manufacturers' materials warranty on parts and labor to repair/replace defective telecommunications station cabling materials. The installer/contractor shall be certified by the manufacturer to provide the materials warranty.
3. One-year installation workmanship warranty on parts and labor to resolve problems related to telecommunications system installation workmanship.

C. The Contractor shall be responsible for, and make good, without expense to Owner, any and all defects arising during this warranty period that are due to imperfect materials, appliances, improper installation, or poor workmanship.
1. During the warranty period, provide all labor required to repair or replace defects in the telecommunications system, at no cost to Owner.
2. Owner representatives must be notified immediately and prior to any repair being done if it is found that work or material found to be damaged, tampered with or removed by others during the warranty period. Owner will not be held liable for payment to contractor for repairs in this situation that were not reported and priced to Owner prior to the work being performed.
3. During the warranty period, provide new materials to repair or replace defects in the telecommunications system, at no cost to Owner.

PART 2 - MATERIALS

2.1 EQUIPMENT AND MATERIALS MINIMUM REQUIREMENTS

A. All materials and equipment provided by the Contractor shall be new, free from defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practices of the industry.

B. Where no specific material, apparatus, or appliance is mentioned, any standard, first-class product made by reputable manufacturer regularly engaged in the production of such material may be used providing it conforms to the contract requirements and meets the approval of Owner IT and the Consultant.

C. Rated materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.

D. Materials shall meet or exceed the following minimum requirements:
1. Where applicable, all materials and equipment shall bear the label and listing of UL. Application and installation of all listed equipment and materials shall be in accordance with such labeling and listing.
2. Equipment shall meet all applicable FCC regulations.
3. Electrical equipment and systems shall meet UL standards and requirements of the NEC. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with these requirements.
4. The listing of a manufacturer as "acceptable" does not include acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the specifications and meet the quality of the specified item.
5. Materials and equipment shall bear the manufacturer's name or trademark and model/serial number permanently marked.

2.2 FACTORY ASSEMBLED PRODUCTS

A. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for the final assembled unit.
   1. All components of an assembled unit need not be products of the same manufacturer.
   2. Constituent parts, which are alike, shall be the product of a single manufacturer.
   3. Components shall be compatible with each other and with the total assembly for intended service.
   4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver the specified performance of the complete assembly.

2.3 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

2.4 SPECIAL TOOLS AND KITS

A. Furnish any special installation equipment, tools, or kits necessary to properly complete the telecommunications system installation. This may include, but is not limited to, tools for pulling, splicing, terminating, and testing the cables, communication devices, stands for cable reels, cable wenches, assembly and adjustment devices, etc.

2.5 FIRESTOPS AND PENETRATION SEAL MATERIALS

A. Use qualified systems to firestop through penetrations in all fire-rated walls, floors, and assemblies for pipes, cables, conduits, ducts, inner-ducts, and cable trays. Contractor’s responsibility to meet UL listed and AHJ requirements.

B. Cabling for telecommunication applications shall be sealed with re-enterable fire-stopping products.

C. Fire-stopping devices shall be pre-manufactured modular devices, containing built-in self-sealing intumescent inserts. Fire-stopping devices shall allow for cable moves, additions or changes without the need to remove or replace any firestop materials. Devices must be capable of maintaining the fire resistance rating of the penetrated membrane at 0% to 100% visual fill of penetrants; while maintaining “L” rating of <5 cfm/sf at 0% to 100% visual fill. Each device must be capable of retrofit applications and be available in square and round configurations, with single, double, triple and six-plex bracket systems provided. Firestop devices must also allow for plastic pipe, metallic pipe, and mixed multiple penetrations (plastic, metallic, insulated metallic, and cable) though a single device.

D. Inside all conduits, the firestop system shall consist of a dielectric, water-resistant, non-hardening, permanently pliable/re-enterable putty along with appropriate damming or backer materials (where required). The sealant must be capable of being removed and reinstalled and must adhere to all penetrants and common construction materials and shall be capable of allowing normal cable movement without being displaced.

E. Approved Firestop Manufacturers:
   1. 3M Fire Protection
   2. Specified Technologies, Inc. (STI)
   3. HILTI

2.6 ANCHORING MATERIALS AND SUPPORTS

A. Metal bars, plates, channel, tubing, etc. shall conform to ASTM Standards:
   1. Steel plates, shapes, bars, and grating – ASTM A36
   2. Cold-formed steel tubing – ASTM A500
   3. Hot-rolled steel tubing – ASTM A501
   4. Steel pipe – ASTM A53, Schedule 40, welded

B. Anchoring Materials:
   1. Structural Steel
   2. Steel Channel: Galvanized or painted
   3. Uni-Strut

PART 3 - EXECUTION

3.1 EXAMINATION OF PROJECT SITE

A. Prior to any project work, examine the project site carefully, including all project drawings showing existing systems and equipment. The Contractor shall be fully informed of, and shall identify, all utility, state, and local requirements that will affect the telecommunications work at the project site.

B. Examine areas and conditions under which the specified work is to be done. Provide written notification to the Owner IT PM of conditions detrimental to proper completion of the work.

C. Verify field measurements and conditions are as shown on project drawings. Provide written notification to the Owner IT PM of conditions deviating from drawings.

D. Beginning of telecommunications work indicates Contractor acceptance of existing conditions.

E. Determine if the installation of the proposed systems will affect the operation or code compliance of existing systems. With Owner approval, relocate, modify, or otherwise revise existing telecommunications systems as required to maintain operational integrity and code compliance.

F. Become familiar with the local conditions under which the work is to be performed and correlate the on-site observations with the requirements of the specifications and project drawings. No allowance will be made for claims of concealed conditions which the Contractor, in exercise or reasonable diligence in examination of the site, observed or should have observed.

G. Before ordering any materials or doing any project work, verify all measurements and be responsible for correctness of same. No extra charge or compensation will be allowed for duplicate work or material required because of unverified differences between actual dimensions and the measurements indicated on the project drawings. Any discrepancies found shall be submitted in writing to the Consultant and the Owner IT PM for consideration before proceeding with the project work

H. The approximate locations of existing and new telecommunications outlets, cabling and equipment will be indicated on the project drawings; however, the drawings are not intended to give complete and accurate information. Field verify existing outlets and cabling prior to submitting a quote. Determine the exact locations after thoroughly examining the general building plans and by actual measurements before and during construction, subject to the approval of Owner IT and the Consultant.

I. Before construction work commences, visit the site and identify the exact routing for all cable pathways and equipment placement. Verify all dimensions, locating the work and its relation to existing work, all existing conditions and their relation to the work and all man-made obstructions and conditions, etc. affecting the completion and proper execution of the work as indicated in the project drawings and specifications.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. All equipment locations shall be coordinated with Owner, other trades and existing conditions to eliminate interference with required clearances for equipment maintenance and inspections.

B. Coordinate work with Owner, other trades and existing conditions to determine exact routing of cable, cable tray, hangers, conduit, etc., before fabrication and installation.

C. If core drills are required, the exact core locations shall be identified and coordinated with Owner Facilities Management. X-rays may be required prior to core drilling in some surfaces. Identify and abide by all Owner core drilling requirements.

D. Install telecommunications cabling and equipment to facilitate maintenance and repair or replacement of equipment components. Provide easy, safe and code mandated clearances at equipment racks and enclosures, and other equipment requiring maintenance and operation. Coordinate with Owner exact location and mounting height of all equipment in finished areas, such as equipment racks, termination equipment, communication and electrical devices. As much as practical, connect equipment for ease of disconnecting, with a minimum of interference with other installations.

E. Coordinate ordering and installation of all materials and equipment with long lead times or having major impact on work by other trades so as not to delay the job or impact the schedule.

F. Set all equipment to accurate line and grade, level all equipment and align all equipment components. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

G. Provide all scaffolding, rigging, hoisting, lifts, and services necessary for delivery, installation, and erection of materials, equipment, and apparatus furnished into the premises. These items shall be removed from premises when no longer required. Use of Owner owned supplies and equipment is prohibited.

H. Labeling
1. The Contractor shall be responsible for printed labels for all cables and cords, distribution frames, and outlet locations, according to OWNER specifications. Labeling shall be in accordance with the recommendations found in TIA/EIA 606A, the manufacturer’s recommendations/installation guides, and industry best practices.
2. All switches, connectors, outlets, etc., shall be clearly logically, and permanently labeled during installation.
3. Label all cables both at the receptacle and equipment rack with vinyl wire markers. Cables shall be labeled in a manner similar to system described above.
4. Labeling scheme shall be approved reviewed and approved by OWNER prior to any labeling.

3.3 WORKMANSHIP

A. All labor shall be thoroughly competent and skilled, and all work shall be executed in strict accordance with the best practice of the trades. When Manufacture requires, all contactors must meet or exceed Manufacture's certification requirements.

B. Good workmanship and appearance shall be considered of equal importance with telecommunications operation. Lack of quality workmanship shall be considered sufficient reason for rejection of a system in part or in its entirety. Carefully lay out all work in advance and install in a neat and workmanlike manner in accordance with recognized good practices and standards. Provide workmen who are skilled in their craft and a competent Project Manager who will be on the job at all times.

3.4 CUTTING AND PATCHING

A. Provide all cutting, patching and core drilling, etc., as necessary for telecommunications work in accordance with Owner Facilities Standards. Locate holes and outlets to be drilled, coordinate with work of other trades, and obtain approval of Owner prior to cutting or core drilling holes greater than ¾" in structural members.

B. Cut and drill from both sides of walls and/or floors to eliminate splaying.

C. Patch adjacent existing work disturbed by installation of new work, including insulation, walls and wall covering, ceiling and floor covering and other finished surfaces. Patch openings and damaged areas equal to existing surface finish.

D. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

E. Openings for electrical work shall be carefully caulked or grouted as required. Spare conduits shall be tightly capped.

F. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

G. Clean up and vacuum all spaces after cutting and patching to remove all debris from the work.

3.5 CONCEALMENT

A. Use existing conduit and cable trays and conceal all project work above ceilings and in walls, below slabs, and elsewhere throughout building where possible and practicable. If concealment is impossible or impracticable, notify the Owner IT PM and the Consultant before starting that part of the work, and install only after approval is given by Owner IT.

3.6 EQUIPMENT MODIFICATION

A. Where existing equipment is to be modified, furnish materials and labor as necessary to modify or add to the equipment. Modifications shall be done neatly with factory parts and assemblies approved for the application. Modification shall in no way jeopardize the compliance of existing equipment with any governing codes and regulations.

3.7 FIRESTOPS AND PENETRATION SEALS

A. All new and existing penetrations through fire-rated walls, floors, ceilings, etc. shall be sealed to prevent the spread of smoke, fire, toxic gas, or water through the penetration before, during, or

after a fire. The fire rating of penetration seal shall be at least that of the wall, floor, or ceiling into which it is installed, so the original fire rating is maintained. The installation shall provide an air and watertight seal. This includes all existing telecommunications cables and pathways to remain within the project area.

B. All new and existing conduit and sleeve openings used for the project shall be waterproofed or fireproofed upon cable placement through such passageways in compliance with Idaho Building and Fire Codes and Owner Facilities Standards.

C. Patch all openings remaining around and inside all new and existing conduit sleeves and cable penetrations to maintain the integrity of any fire-rated wall, floor, ceiling, etc.

D. Manufacturer's installation standards shall be closely followed (minimum depth of material, use of ceramic fiber, procedures, etc.).

E. Cable Trays: All new cable tray pathways shall not penetrate fire-rated walls. Cable tray shall stop within 6 inches of the wall and a fire-rated assembly shall be used for the wall penetration, such as EZ path product or equivalent approved by Owner IT.

F. Seal all foundation penetrating conduits and all service entrance conduits and sleeves to eliminate the intrusion of moisture and gases into the building. This requirement also includes spare conduits.

G. Spare conduits shall be plugged with expandable plugs.

H. All service entrance conduits through the building shall be sealed or resealed upon cable placement.

I. Entrance conduits with cables in them shall be permanently sealed by firmly packing the void around the cable with oakum and capping with a hydraulic cement or waterproof duct seal.

3.8 ANCHORING METHODS

A. Anchor and brace all cabling, material, and equipment installed under this Division as required by all codes, regulations, and standards. Provide required supports, beams, angles, hangers, rods, bases, braces, straps, struts, and other items to properly support project work. Supports shall meet the approval of Owner.

B. Supports shall be fabricated from structural steel, steel channel, or uni-strut, rigidly bolted or welded to present a neat appearance.

C. Fastenings and supports shall be adequate to support loads with ample safety factors.

D. Fasten hanger rods, conduit clamps, outlet boxes, and pull-boxes to building structure.

E. Use toggle bolts, spider type expansion anchors, or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls.

F. Use lead expansion shields or expansion anchors or preset inserts in solid masonry walls.

G. Use self-drilling anchors or lead expansion anchor on concrete surfaces.

H. Use sheet metal screws in sheet metal studs.

I. Use wood screws in wood construction.

J. In pre-cast structures, use cast-in inserts wherever possible. Expansion anchors can be used with caution, but only with prior approval.

K. In cast-in-place concrete, use expansion anchors, preset inserts, or self-drilling masonry anchors.

L. Use lead expansion anchors, or preset inserts on metal surfaces.

M. Do not fasten supports to piping, ceiling support wires, ductwork, mechanical equipment, or conduit.

N. Power-actuated anchors, plastic or fiber expansion anchors, and drive pin anchors are prohibited.

O. Do not drill structural steel members.

P. Any anchoring must be able to be unsecured and removed should relocation be required. The old Hilti HIT-pin is not acceptable.

Q. Where necessary and with approval from Owner, modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit project work. If necessary, in stud walls provide special supports from floor to structure above.

R. For precast panels/planks and metal decks, support communication work as determined by manufacturer and Owner.

S. Provide heavy gauge steel mounting plates for mounting project work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

T. Install freestanding telecommunications equipment on concrete pads.

U. Support surface mounted cabinets, enclosures, and panel boards with a minimum of four anchors.

V. On exterior concrete walls below grade, provide 1” steel channel stand-offs for cabinets and raceways.

W. Use stud bridges at top and bottom of cabinets and enclosures that are flush mounted on hollow drywall walls.

X. Use suitable vibration isolation pads for vibrating equipment.

3.9 ENGINEERING

A. Planning meetings and schedule
   1. An initial planning meeting will be held with the successful bidder to:
      a. Clarify all requirements (systems, services, distribution methods, etc.),
      b. Identify responsibilities,
      c. Schedule the events that will transpire during the implementation of the project.

2. Within two (2) weeks of the initial meeting, the contractor shall provide a written report and project schedule to clearly document the events and responsibilities associated with the project.

B. Drawings and review
1. In order to start the initial engineering phase, Architect shall provide the Contractor with one (1) clearly readable, up to date scale copy of all architectural, electrical, and mechanical drawings, two (2) weeks prior to the commencement of any engineering design activities. This will allow for a one (1) week review of the diagrams by the Contractor and allow one (1) week for Consultant to answer any queries pertaining to the Contractor's review. In reviewing such drawings Contractor shall be obligated to make an on-site inspection with Consultant and its General Contractor for on-site verification of access routes for cabling and other matters.

C. Proposed wiring solution
1. Upon completion of the initial engineering stage, the Contractor shall provide two (2) draft copies of engineering documentation for approval by OWNER and Consultant. OWNER and Consultant will review the engineering documentation within a two (2) week period.
2. This documentation will include, but is not limited to the following:
   a. A detailed drawing of each TR.
3. If no revisions are required, the documentation shall be formally accepted in writing by OWNER and Consultant.
4. Any revisions shall be completed by the contractor within a two (2) week time period and resubmitted for review.

D. Drawings and diagrams
1. Upon completion of final engineering and incorporation of OWNER and Consultant review comments, Contractor shall provide to OWNER for its records the following:
   a. TR Diagrams which shall include:
      1) Cable routing
      2) Position of all components and
      3) Detailed layout of the wall-field
      4) Labeling plan.
   b. Work Area Floor Plans which shall include:
      1) Detailed cable routes
      2) Approved labeling plan for all work areas.
   c. Cross Connect Documentation which shall include:
      1) Cross connect records for all voice, and data devices.
   d. Cable Tray, Conduit, and Raceway Plans
      1) Documentation shall be in the following format:
   e. See Division 1 for documentation requirements

E. As Built Documentation
1. Upon completion of the project, Contractor is to prepare "As Built" documentation showing actual site conditions and installation as constructed.
2. Provide copies of such documentation to Owner IT as mentioned above.

F. Additional Records
1. In addition to the engineering diagrams, the following items shall be provided by the contractor:
   a. Cable Records and Assignments

END OF SECTION

SECTION 27 05 26 – GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of telecommunications grounding and bonding for the Structured Cabling System as called for in these specifications and related drawings.

1.2 SYSTEM DESCRIPTION:

A. Each Telecommunications Room (TR) in a building shall have a Telecommunications Grounding Busbar (TGB) properly connected per TIA-607-B.

B. Relevant bonding and grounding infrastructure acronyms:
1. EK (Equipment Bonding Conductor): An insulated copper conductor that bonds metallic items and equipment to the TMGB and TGB.
2. IC (Interconnecting Bonding Conductor) (referred to in TIA-607-B as the Bonding Conductor for Telecommunications): The copper conductor that bonds the TMGB to the service equipment (power) ground.
3. TBB (Telecommunications Bonding Backbone): An insulated copper conductor extending from the TMGB to each TGB.
4. TGB (Telecommunications Grounding Busbar): A copper ground reference busbar, typically installed in telecommunications rooms (TR) that is bonded to the TMGB by the TBB. The TGB references metallic entities in the TR space to ground.
5. TMGB (Telecommunications Main Grounding Busbar): A copper ground reference busbar, typically installed in the entrance facility or entrance room that is bonded to the service equipment (power) ground by the IC.

1.3 ACTION SUBMITTALS:

A. Refer to Section 27 05 00 Common Work Results for Communications

1.4 QUALITY ASSURANCE:

A. Comply with Section 27 05 00.

B. All work shall confirm to Article 250-Grounding and Article 800-Communications of the National Electrical Code (NEC) for grounding, bonding, and protecting electrical and communications circuits.

C. Materials and work specified herein shall comply with the applicable requirements of TIA-607-B Commercial Building Grounding and Bonding Requirements for Telecommunications.

D. Materials and work specified herein shall comply with the applicable requirements of IEEE-426.

E. If there is a conflict between the grounding standards, follow IEEE-426 as the primary standard.

F. Delivery, storage and handling.

G. Comply with Section 27 05 00.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION:

A. Telecommunication Main Grounding Busbar (TMGB) shall be1/4” x 4” x 20” insulated copper ground bar in size.

B. Telecommunication Grounding Busbar (TGB) shall be 1/4” x 4” x 10” insulated copper ground bar in size.

C. Equipment Rack Busbars shall be 1/4” x 1” x 19” rack ground bar in size.

D. Bonding Conductors:
1. All bonding conductors shall be insulated copper. The exception is the use of flat, braided, aluminum ground straps utilized for bonding sections of aluminum cable trays.
2. Unless otherwise specified, the IC (Interconnecting Bonding Conductor) (referred to in TIA-607 as the Bonding Conductor for Telecommunications) shall be insulated, copper, No. 3/0 AWG.
3. Unless otherwise specified, the TBB (Telecommunications Bonding Backbone) shall be green-colored (or identified as a grounding wire every 10 feet) insulated, copper, No. 3/0 AWG.
4. Unless otherwise specified, the EK (Equipment Bonding Conductor) shall be green-colored insulated, copper, No. 6 AWG.

E. Bonding conductor terminations acceptable materials:
1. Two-hole compression lugs: Color coded to appropriate cable, high conductivity wrought copper, electro tin plated, or approved equal.
2. One-hole compression lugs: Color coded to appropriate cable, high conductivity wrough copper, electro tin plated, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Comply with Section 27 05 00.

3.2 INSTALLATION:

A. Provide all local bonding as specified on the drawings and in the specifications.

B. Bonding conductors shall be continuous and routed in as direct a route as possible to the point of termination.

C. All insulated ground bars must be isolated from the structural support by a 2-inch minimum separation, using manufacturer’s recommended insulating stand-offs and hardware.

D. Clean ground bars prior to terminating conductors.

E. Label all telecommunications bonding conductors as close as possible to their termination point.

F. Confirm that the electrical contractor bonded the TMGB to the service equipment (power) ground, typically located in the electrical entrance facility, utilizing the most direct route possible to minimize conductor length.

G. Bond the following when present:
   1. Metallic equipment racks.
   2. Cable shields.
   3. All metal raceways and cable trays.

END OF SECTION 27 05 26

SECTION 27 05 28 - CABLE TRAY FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SECTION INCLUDES:

A. Carbon steel wire mesh cable management system.

B. Cable tray systems are defined to include, but are not limited to, straight sections, supports and accessories.

1.3 SUBMITTALS:

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray:
   1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   2. Coordination Drawings: Coordinate layout and installation of cable tray with other installations. Revise locations and elevations from those indicated as required to suit field conditions, only as approved by the Architect and Engineer. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

C. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

D. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval prior to submission of bid.

1.4 QUALITY ASSURANCE:

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Classified and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Ensure manufacturers comply with ISO 9001 quality standards.

D. Comply with NFPA 70, National Electric Code, Article 392: Cable Trays; provide UL Classification and labels.

E. Comply with IEC 61537, Cable Tray Systems and Cable Ladder Systems for Cable Management.

F. Comply with NEMA VE 1, Metal Cable Tray Systems, for materials, sizes, and configurations.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

B. All cable trays shall be stored in a well-ventilated, dry location. Unpack and dry wet materials before storage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Refer to 27 06 00 Schedules for Communication Systems

2.2 MATERIALS AND FINISHES:

A. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.
1. Electrodeposited Zinc Plating before fabrication, complying with ASTM B 633 Type III, SC-1; with hardware galvanized according to ASTM B 633.

B. Cable Trays, Fittings, and Accessories: ASTM B 633 for fabricated parts; with chromium-zinc, ASTM F 1136, splice-plate fasteners, bolts, and screws.

C. Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe-T-Edge, T-welded, top side wire to protect cable insulation and installers.

2.3 CABLE TRAY ACCESSORIES:

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as cable tray.

C. Fittings/Supports: Wire mesh cable tray fittings are field-fabricated from straight sections, in accordance with manufacturer’s instructions. Supports will include the FAS (Fast Assembly System), where possible. Place supports so that spans do not exceed seven (7) foot maximum spans.

2.4 SIZES AND CONFIGURATIONS

A. Refer to drawings for exact cable tray sizes.

B. Cable tray shall be supported with a “Trapeze” style hanger unless otherwise noted.

C. Center-hanger supports may not be used.

2.5 SOURCE QUALITY CONTROL:

A. Perform design and production tests according to NEMA VE 1.

2.6 WATERFALLS

A. Provide a waterfall off of the side of the cable tray at each zone box location.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION:

A. Cable trays and hangers should use established routes as shown on the plans.

B. Cable trays dedicated for communications cables shall be used to support and protect low voltage Divisions 27 cabling only. Under no circumstances shall line voltage electrical cabling be located within any tray, used to route Divisions 27 cabling. Cable trays must not be placed to allow hangers or supports for ceiling grid, plumbing, electrical, or any other mechanical systems to pass through the trays.

C. Cable trays, cable basket, and hangers must be installed in such a manner that all installed cable can be routed to maintain EIA/TIA and BICSI standards for keeping the proper distances away from Electro Magnetic Interference (EMI) or Radio Frequency Interference (RFI) producing fixtures AC power cables, motors, transformers, fluorescent lighting ballasts, and other EMI/RFI generating equipment. High voltage, high emissions equipment may require greater distances.

D. Cable trays shall be installed with a minimum clearance of 18 inches between the frame of the tray or basket on one side and any items in the immediate ceiling area and a minimum of 12” above.

E. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

F. Remove burrs and sharp edges from cable trays.

G. Fasten cable tray supports to building structure.
   1. Place supports so that spans do not exceed seven (7) foot maximum spans.
   2. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
   3. Support cable tray assembly to prevent twisting from eccentric cable loading.
   4. Locate and install supports according to NEMA VE 1.

H. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

I. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

J. Make changes in direction and elevation using standard transitions listed below.
   1. Sweeping 90, Sweeping Tee

K. Make cable tray connections using standard fittings.

3.2 WARNING SIGNS:

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. See manufacturer’s instructions for mounting requirements.

3.3 CONNECTIONS:

A. Ground cable trays according to manufacturer's written instructions and in compliance with NEC Article 250.

3.4 FIELD QUALITY CONTROL:

A. After installing cable trays survey for compliance with requirements. Perform the following field quality-control survey:

1. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
3. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
4. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
5. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

B. Report results in writing.

3.5 PROTECTION:

A. Protect installed cable trays.
   1. Repair damage to electro-galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

END OF SECTION 27 0528

SECTION 27 05 44 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. 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. 07 84 13 Penetration Firestopping

1.3 ACTION SUBMITTALS

A. Refer to Section 27 05 00 Common Work Results for Communications

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. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel or Plastic**.**
3. 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. Sleeve-seal fittings in this article are used for conduit penetrations in slabs-on-grade and in exterior walls. These fittings are made to match conduit OD, so they must be selected to match the penetrating piping size. They are available for NPS 1/2 to 6 (DN 15 to 150) piping.

B. 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.

2.4 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

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

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "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**] [**cast-iron**] 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 27 05 44

SECTION 27 0553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Color and legend requirements for labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes.
5. Signs.
6. Cable ties.
7. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Refer to Section 27 05 00 Common Work Results for Communications

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606-B.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Differential values in "Temperature Change" Subparagraph below (for aluminum in particular) are suitable for most of the United States.
2. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:
1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, polyester or vinyl flexible labels with acrylic pressure-sensitive adhesive.
   1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
   2. Marker for Labels: Permanent, waterproof black ink marker recommended by tag manufacturer.
   3. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
   1. Minimum Nominal Size:
      a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
      b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
      c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.

2.6 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch (5 mm).
   2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
   3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
   4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   1. Minimum Width: 3/16 inch (5 mm).
   2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

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

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

H. Vinyl Wraparound Labels:
1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
3. Provide label 6 inches (150 mm) from cable end.

I. Snap-Around Labels:
1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches (150 mm) from cable end.

J. Self-Adhesive Wraparound Labels:
1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches (150 mm) from cable end.

K. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

M. Underground-Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench **or** concrete envelope exceeds 16 inches (400 mm) overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Cable Ties: General purpose, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
1. System legends shall be as follows:
a. Telecommunications.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation**,** numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
1. Wiring closet designation.
2. Colon.
3. Faceplate number.

E. Equipment Room Labeling:
   1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
   2. Patch Panels: //Label individual rows in each rack, starting at top and working down, with self-adhesive labels.
   3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
      a. Room number being served.
      b. Cable/Port number.
      c. Faceplate number.

F. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

G. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
   1. Room number.
   2. Cable/Port number.
   3. Faceplate number.

H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

I. Instructional Signs: Self-adhesive labels.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
   1. Apply to exterior of door, cover, or other access.

K. Equipment Identification Labels:
   1. Indoor Equipment: Self-adhesive label.
   2. Equipment to Be Labeled:
      a. Communications cabinets.
      b. Uninterruptible power supplies.
      c. Computer room air conditioners.
      d. Fire-alarm and suppression equipment.
      e. Egress points.
      f. Power distribution components.
      g. Patch Panels.
      h. Cables.
      i. Conduit.
      j. Grounding conductors and busbars.

END OF SECTION 27 05 53

SECTION 27 06 00 - SCHEDULES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections.

B. Architectural, Electrical, Structural, Civil, Mechanical, Plumbing, Fire Protection, and Technology Drawings & Specifications. Other systems drawings may apply. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

1.2 SUMMARY

A. This section includes the associated equipment schedules appendices for all other sections. Refer to each section for specific details related to the equipment schedules below.

B. The manufacturers and part numbers listed are the basis of design. Part numbers and manufacturers may be substituted with products that meet or exceed the performance listed. Submit substitution requests to the Technology Consultant prior to bidding.

C. Four manufacturers are listed in the COMMUNICATIONS HORIZONTAL CABLING SCHEDULES section. Any of the four can be selected in their entirety but mixing material between several manufacturers in not permitted.

PART 2 - MATERIALS

2.1 SECTION 27 05 29 – CABLE TRAY FOR COMMUNICATION SYSTEMS

Line	Description	Manufacturer	Part Number
1	12” x 4” WIRE BASKET CABLE TRAY	LEGRAND	CF105300EZ
	THE ABOVE MATERIAL MAY BE SUBSTITUTED WITH MATERIAL BY EATON OR MONOSYSTEMS		

2.2 SECTION 27 11 00 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

Line	Description	Manufacturer	Part Number
1	12”W X 10’ BLACK LADDER RACK	CHATSWORTH	10250-712
2	CABLE RUNWAY, E-BEND 12”, BLACK	CHATSWORTH	10822-712
3	OUTSIDE RADIUS BEND, 12” BLACK	CHATSWORTH	10723-712
4	INSIDE RADIUS BEND, 12” BLACK	CHATSWORTH	10724-712
5	BUTT-SPLICE KIT, BLACK	CHATSWORTH	1103-701
6	JUNCTION-SPLICE KIT, BLACK	CHATSWORTH	11302-701
7	HEAVY-DUTY BUTT-SPLICE KIT, BLACK	CHATSWORTH	11299-701
8	HEAVY-DUTY JUNCTION SPLICE KIT,	CHATSWORTH	11298-701
9	ADJUSTABLE JUNCTION SPLICE KIT,	CHATSWORTH	10616-701
10	90° RUNWAY-SPLICE KIT, BLACK	CHATSWORTH	11314-701
11	45° RUNWAY-SPLICE KIT, BLACK	CHATSWORTH	11313-701

12	BUTT SWIVEL SPLICE KIT, BLACK	CHATSWORTH	10487-701
13	JUNCTION SWIVEL SPLICE KIT, BLACK	CHATSWORTH	10488-701
14	VERTICAL SWIVEL SPLICE KIT, BLACK	CHATSWORTH	10489-701
15	GROUNDING KIT, ZINC	CHATSWORTH	12061-001
16	TRIANGULAR SUPPORT BRACKET, FOR 6”-12” WIDE LADDER RACK, 100 LB. CAPACITY, BLACK	CHATSWORTH	11312-712
17	WALL ANGLE SUPPORT KIT, FOR 12”	CHATSWORTH	11421-712
18	FOOT KIT, STEEL, GOLD	CHATSWORTH	11309-001
19	ADJUSTABLE FLOOR SUPPORT CHANNEL, FOR 12” WIDE LADDER RACK	CHATSWORTH	11241-712
20	CENTER SUPPORT KIT, FOR 12” LADDER	CHATSWORTH	12362-712
21	RACK-TO-RUNWAY MOUNTING PLATE, FOR 9” TO 12” WIDE LADDER RACK	CHATSWORTH	10595-112
22	TWO-POST RACK 19” RACK	CHATSWORTH	55053-703
23	6” VERTICAL WIRE MANAGER	CHATSWORTH	30095-703
24	10” VERTICAL WIRE MANAGER	CHATSWORTH	30096-703
25	HORIZONTAL WIRE MANAGER	CHATSWORTH	30130-719
	THE ABOVE MATERIAL LISTED BY CHATSWORTH MAY BE SUBSTITUTED WITH MATERIAL BY B-LINE OR HOFFMAN		

2.3 SECTION 27 15 00 – COMMUNICATIONS HORIZONTAL CABLING SCHEDULES

Line	Description	Manufacturer	Part Number
	COMMSCOPE SOLUTION		
1	CATEGORY 6 CABLING	COMMSCOPE	CS37
2	MODULAR JACK, CAT6, RJ45,	COMMSCOPE	UNJ600-XX
3	24 PORT PATCH PANEL CAT 6	COMMSCOPE	UNP-6-DM-1U-24
4	48 PORT PATCH PANEL CAT 6	COMMSCOPE	UNP-6-DM-2U-48
5	VOICE GRADE PATCH PANEL 24 PORT	COMMSCOPE	1711213-X
6	PATCH PANEL LABEL	COMMSCOPE	760199570
7	FACE PLATE KIT PHONE 1 PORT WALL	COMMSCOPE	1-1479152-3
8	LE TYPE FLUSH MOUNTED FACEPLATE - 1	COMMSCOPE	M10LE-148
9	LE TYPE FLUSH MOUNTED FACEPLATE - 2	COMMSCOPE	M12LE-148
10	LE TYPE FLUSH MOUNTED FACEPLATE - 4	COMMSCOPE	M14LE-148
11	LE TYPE FLUSH MOUNTED FACEPLATE - 6	COMMSCOPE	M16LE-148
12	COAXIAL COUPLER F INSERT	COMMSCOPE	M81C
	BELDEN SOLUTION		
1	CATEGORY 6 CABLING	BELDEN	3613
2	UNIPRISE MODULAR JACK, CAT6, RJ45,	BELDEN	RV6MJKUBK
3	24 PORT PATCH PANEL CAT 6	BELDEN	RV6PPF2U24BK
4	48 PORT PATCH PANEL CAT 6	BELDEN	RV6PPF2U48BK
5	VOICE GRADE PATCH PANEL 24 PORT	BELDEN	HD-110 PP 24 IU
6	FACE PLATE KIT PHONE 1 PORT WALL	BELDEN	AX10200-X

7	LE TYPE FLUSH MOUNTED FACEPLATE - 1	BELDEN	AX103922-XX
8	LE TYPE FLUSH MOUNTED FACEPLATE - 2	BELDEN	AX103923-XX
9	LE TYPE FLUSH MOUNTED FACEPLATE - 4	BELDEN	AX102248-XX
10	LE TYPE FLUSH MOUNTED FACEPLATE - 6	BELDEN	AX102250-XX
11	COAXIAL COUPLER F INSERT	BELDEN	AX105346-XX
	SUP/ESSEX SOLUTION		
1	CATEGORY 6 CABLING	SUP/ESSEX	77-272-XB
2	MODULAR JACK, CAT6, RJ45,	ORTRONICS	OR-TJ600
3	24 PORT PATCH PANEL CAT 6	ORTRONICS	OR-SP6U24
4	48 PORT PATCH PANEL CAT 6	ORTRONICS	OR-SP6U48
5	VOICE GRADE PATCH PANEL 24 PORT	ORTRONICS	OR-808004339
6	FACE PLATE KIT PHONE 1 PORT WALL	ORTRONICS	OR-WMTE14-XX
7	LE TYPE FLUSH MOUNTED FACEPLATE - 1	ORTRONICS	KSFP1-XX
8	LE TYPE FLUSH MOUNTED FACEPLATE - 2	ORTRONICS	KSFP2-XX
9	LE TYPE FLUSH MOUNTED FACEPLATE - 4	ORTRONICS	KSFP3-XX
10	LE TYPE FLUSH MOUNTED FACEPLATE - 6	ORTRONICS	KSFP4-XX
11	COAXIAL COUPLER F INSERT	ORTRONICS	OR-WP348-XXX
	LEV/BERK-TEK SOLUTION		
1	CATEGORY 6 CABLING	LEV/BERK-TEK	CX6000
2	MODULAR JACK, CAT6, RJ45,	LEV/BERK-TEK	61SJK-RX6
3	24 PORT PATCH PANEL CAT 6	LEV/BERK-TEK	69270-U24
4	48 PORT PATCH PANEL CAT 6	LEV/BERK-TEK	69270-U48
5	VOICE GRADE PATCH PANEL 24 PORT	LEV/BERK-TEK	49013-J24
6	FACE PLATE KIT PHONE 1 PORT WALL	LEV/BERK-TEK	402XX-X
7	LE TYPE FLUSH MOUNTED FACEPLATE - 1	LEV/BERK-TEK	42080-XXX
8	LE TYPE FLUSH MOUNTED FACEPLATE - 2	LEV/BERK-TEK	42080-XXX
9	LE TYPE FLUSH MOUNTED FACEPLATE - 4	LEV/BERK-TEK	42080-XXX
10	LE TYPE FLUSH MOUNTED FACEPLATE - 6	LEV/BERK-TEK	42080-XXX
11	COAXIAL COUPLER F INSERT	LEV/BERK-TEK	41084-F-XX
13	PENDENT MOUNT WAP ENCLOSURE	OBERON	900-HC-WT

2.4 SECTION 27 60 00 – TELEVISION DISTRIBUTION SYSTEMS

Line	Description	Manufacturer	Part Number
1	RG-6 CABLING 90% BRAID PLENUM – WHITE	COMMSCOPE, BELDEN, OR EQUAL	2229V
2	RG-6 F CONNECTOR	DIGICON	DS6
3	SPLITTER / DIRECTIONAL COOUPLER	BLONDER TONGUE, HOLLAND, OR EQUAL	
4	AMPLIFIER (IF REQUIRED)	BLONDER TONGUE, HOLLAND, OR EQUAL	BIDA 550-50

END OF SECTION

SECTION 27 11 00 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections.

B. Architectural, Electrical, Structural, Civil, Mechanical, Plumbing, Fire Protection, and Technology Drawings & Specifications. Other systems drawings may apply. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

1.2 SUMMARY

A. Provide all services, labor, materials, tools, and equipment required for the complete and proper installation within the Telecommunications Room as called for in these specifications and related drawings.

B. This section includes minimum requirements and installation methods for the following:
   1. Equipment Racks and Cable Routing Hardware
   2. Copper Termination Equipment
   3. Fiber Termination Equipment
   4. Coaxial Termination Equipment
   5. Grounding and Bonding

1.3 QUALITY ASSURANCE

A. All installation work in the Telecommunications Rom shall be performed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated shall be subject to the control of the Owner.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval of the Owner based on submittals provided.

C. Installations, materials, equipment and workmanship shall conform to the specifications and drawings and all applicable provisions of the most recent versions of the following regulations, codes, and standards including all applicable addenda:
   1. ANSI/NFPA 70 – National Electrical Code including, but not limited to, the following articles:
      a. 250 – Grounding and Bonding
      b. 300 – Wiring Methods
      c. 645 – Information Technology Equipment
      d. 725 – Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits
      e. 770 – Optical Fiber Cables and Raceways

f. 800 – Communications Circuits
2. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
3. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
4. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
5. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
6. ANSI/TIA-568-C.4 – Broadband Coaxial Cabling and Components Standard
7. ANSI/TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA-604 Series – Fiber Optic Connector Intermateability Standards
9. ANSI/TIA-606-B – Administration Standard for Commercial Telecommunications Infrastructure
10. ANSI/TIA-607-B – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
11. BICSI Telecommunications Distribution Methods Manual
12. BICSI Telecommunications Cabling Installation Manual
13. FCC CFR 47 Part 68 – Direct Connection of Terminal Equipment to the Public Switched Telephone Network (PSTN)

PART 2 - MATERIALS

2.1 EQUIPMENT AND MATERIALS REQUIREMENTS

A. Refer to Sheet Notes and Specification 27 06 00 Schedules for Communications for product data and part numbers.

PART 3 – EXECUTION

3.1 LADDER RACK:

A. Provide all components of the ladder rack system (ladder rack, turns, splices, supports, and accessories) from a single manufacturer.

B. Ladder rack shall be installed with side stringers facing down so that the ladder forms an inverted U-shape and so that welds between the stringers (sides) and cross members (middle) face away from cables.

C. Ladder rack shall be secured to the structural ceiling, building truss system, wall, floor or the tops of equipment racks and/or cabinets using the manufacturer’s recommended supports and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).

D. Ladder rack splices will be made in mid-span, not over a support, with the manufacturer’s recommended splice hardware.

E. Ladder rack shall be supported every 5’ or less in accordance with TIA-569-C. Ladder rack shall be supported within 2’ of every splice and within 2’ on both/all sides of every intersection. Support ladder rack within 2’ on both sides of every change in elevation. Support ladder rack every 2’ when attached vertically to a wall.

F. Heavy-duty splices are recommended for ladder rack in excess of 18” width (18” wide ladder rack). Heavy-duty splices are required for any splice formed in the vertical orientation including changes in elevation formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns. Use heavy-duty splices to secure all overhead turns to the overhead horizontal pathway(s).

G. When the pathway is overhead, ladder rack shall be installed with a minimum clearance of 12” above the ladder rack. Leave a minimum of 12” in between ladder rack and ceiling/building truss structure. Leave a minimum of 3” in between ladder rack and the tops of equipment racks and/or cabinets. Multiple tiers of ladder rack shall be installed with a minimum clearance of 12” in between each tier of ladder rack. When located above an acoustical drop ceiling, leave a minimum of 3” clearance between the top of the drop ceiling tiles and the bottom of the ladder rack.

H. When installed under a raised floor, ladder rack shall be installed with a minimum 3” clearance between the top of the ladder rack and the bottom of the floor tiles or floor system stringers, whichever is lower in elevation. Maintain a 3” clearance between ladder racks wherever ladder racks cross.

I. Within each Telecommunications Room, ladder rack should be bonded together, electrically continuous, and bonded to the Telecommunications Grounding Busbar (TGB), unless otherwise noted in the specifications and contract documents. Ladder rack and turns shall be bonded across each splice with a bonding kit. Ladder rack shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the ladder rack and a minimum #6 grounding wire or as recommended by the AHJ.

J. Remove factory paint from the ladder rack where bonding/ground lugs contact the ladder rack so that the lug will contact bare metal. Use antioxidant joint compound in between the bare metal on the ladder rack and ground lug. Use antioxidant joint compound in between the bus bar and the ground lug. Verify continuity through the bonds at splices and intersections between individual ladder rack sections and connection points to the TGB.

K. The quantity of cables within the ladder rack will not exceed a whole number value equal to 50% of the interior area of the ladder rack divided by the cross-sectional area of the cable. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2”, unless cable retaining posts are added to the ladder rack. The interior area of ladder rack equipped with cable retaining posts will be considered to be the width of the ladder rack multiplied by a height of 6”. Actual cable fill for ladder rack that is not equipped with cable retaining posts will not exceed 2” in height. Actual cable fill for ladder rack equipped with cable retaining posts will not exceed 6” in height.

L. The combined weight of cables within the ladder rack will not exceed the stated load capacity of the ladder rack as stated in the manufacturer’s product specifications or load/design tables.

M. Cables (cable bundles) will be secured to the cross members of ladder rack with ¾” wide reusable straps. Straps are not required when ladder rack is equipped with cable retaining posts.

N. Add 8” high cable retaining posts to the open sides of ladder rack when cable fill exceeds 2” in height or when cable bundles cannot be secured directly to the ladder rack cross members with a strap. Cable fill within any ladder rack should not exceed 6” in height.

O. When a single ladder rack supports different types of cable media, the cable media will be separated within the pathway by cable spools that attach to the cross members on the ladder

rack. Treat each type of cable media and divided area of the ladder rack separately when determining cable fill limits.

P. Use a radius drop to guide cables wherever cable exits overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field. If necessary, provide a moveable cross member also to attach and align the radius drop in between the welded cross members of a ladder rack.

Q. Cover the exposed ends of cable runway that do not terminate against a wall, the floor or the ceiling with end caps or an end closing kit.

R. Use auxiliary support brackets that attach to the side stringer of the ladder rack to support interconnect cabling (patch cords, equipment cords, jumper cords) that is routed between racks using the ladder rack. Auxiliary support brackets can be used to support other conductors that should be physically separated from cables within the ladder rack as defined by local code or the authority having jurisdiction (AHJ).

S. Whenever possible, maintain a 2’ separation between ladder rack used for communications cables and pathways for other utilities or building services.

T. The installer will provide touch-up paint color-matched to the finish on the ladder rack and will correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the owner. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, the component will be replaced with a new component finished from the factory. If a component is physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the ladder rack system.

3.2 HORIZONTAL CABLE MANAGERS:

A. When more than one horizontal cable manager is used on a rack/frame/cabinet or group of racks/frames/cabinets, use the same make, and style of cable manager on the rack/frame/cabinet or racks/frames/cabinets.

B. The color of the rack(s)/frame(s)/cabinet(s) and cable manager(s) must match.

C. Attach horizontal cable managers to the rack/frame/cabinet with four screws according to the manufacturer’s installation instructions. Each cable manager should be centered within the allocated rack-mount space (RMU).

D. Horizontal managers will be located so that the number of ports (cables) they support will not exceed the cable fill capacity of the cable manager.

E. Covers should be attached to the cable manager and in the closed position after cabling is complete.

3.3 VERTICAL CABLE MANAGERS:

A. Attach vertical cable managers to the side of the rack/frame using the manufacturer’s installation instructions and included hardware.

B. When a single vertical cable manager is used in between two racks/frames, attach the vertical cable manager to both racks/frames.

C. When more than one cable manager is used on a rack/frame or group of racks/frames, use the same make, style and size of vertical cable manager on the rack/frame or in between racks/frames.

D. The color of the rack(s)/frame(s) and cable manager(s) must match.

E. Doors should be attached to the cable manager and in the closed position after cabling is complete.

3.4 COAXIAL TERMINATION EQUIPMENT INSTALLATION

A. Other than equipment specifically designed for rack-mounting, all equipment intended for CATV distribution shall be wall mounted.

B. All active and passive wall-mounted equipment shall be attached using mounting plates and hardware providing a solid installation.

C. All equipment shall be mounted so that adequate air flow is provided for heat dissipation.

D. All backbone connectors shall be attached and tightened to product specifications.

E. Heat shrink tubing shall be used on Outside Plant (OSP) cable connections. It will not be used on any inside cable not having flooding compound.

END OF SECTION 27 11 10

SECTION 271116 – COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

1.2 SCOPE OF WORK

A. This section includes the minimum requirements for the equipment and cable installations in communications equipment rooms (Telecommunications Rooms).

B. Included in this section are the minimum composition and room requirements and installation methods for the following:

1. Racks

1.3 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval prior to submission of bid.

B. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.

C. Material and work specified herein shall comply with the applicable requirements of:
1. ANSI/TIA/EIA – 568-C Commercial Building Telecommunications Cabling Standard, 2010-2012
2. TIA – 569-C Commercial Building Standard for Telecommunications Pathways and Spaces, 2012
3. ANSI/TIA/EIA – 606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2008
4. ANSI-J-STD – 607-B Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2011
5. NFPA 70 – National Electric Code, 2008
6. BICSI – Telecommunications Distribution Methods Manual, 12th Edition, 2011

1.4 SUBMITTALS

A. Provide product data for the following:
1. Manufacturers cut sheets, specifications and installation instructions for all products.

PART 2 - PRODUCTS

2.1 EQUIPMENT RACKS

A. Free Standing Relay Racks (Standard Rack)
   1. Racks shall be manufactured from aluminum and/or steel extrusion.
   2. Each rack will have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment-mounting channels. The rack will assemble with nut and bolt hardware. The base angles will be pre-punched for attachment to the floor.
   3. Equipment mounting channels will be 3” deep and punched on the front and rear flange with the EIA-310-D Universal hole pattern to provide 45 and 51 rack-mount spaces for equipment. Each mounting space will be marked and numbered on the mounting channel.
   4. When assembled with top and bottom angles, equipment-mounting channels will be spaced to allow attachment of 19” EIA rack-mount equipment. Attachment points will be threaded with 12-24 roll-formed threads. The rack will include assembly and equipment-mounting hardware. Racks will include 50 each combination pan head, pilot point mounting screws.
   5. The assembled rack will measure 7’ (84”) high, 20.3” wide and 15” deep. The sides (webs) of the equipment-mounting channels will be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying.
   6. The rack will be rated for 1,000 lb. of equipment.
   7. The rack will be UL Listed.
   8. Finish shall be either clear grained aluminum or epoxy-polyester hybrid powder coat in the color as specified below.
      a. Design Make:
         1) Chatsworth Products (CPI):
         2) 55053-703
         3) Or approved equal

B. Rack Accessories
   1. Hardware:
   2. Equipment Mounting Screws, #12-24, 50 pack, Black

PART 3 - EXECUTION

3.1 INSTALLATION

A. Relay Racks and cabinets
   1. Assemble relay racks and equipment cabinets according to manufacturer’s instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
   2. All racks and cabinets must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below. Racks shall be grounded directly to the TGB using appropriate hardware provided by the contractor. The ground will meet local code requirements and will be approved by the Authority Having Jurisdiction (AHJ).
   3. In seismic areas, the rack or cabinet should have additional bracing as required by building codes and the recommendations of a licensed structural engineer.
   4. Ladder rack may be attached to the top of the rack or cabinet to deliver cables to the rack. The rack or cabinet should not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.

5. The equipment load should be evenly distributed and uniform on the rack or in cabinet. Place large and heavy equipment towards the bottom. Secure all equipment to the racks and cabinets with equipment mounting screws.

END OF SECTION 271116

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SECTION 27 15 00 – COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections.

B. Architectural, Electrical, Structural, Civil, Mechanical, Plumbing, Fire Protection, and Technology Drawings & Specifications. Other systems drawings may apply. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

1.2 SUMMARY

A. Provide all services, labor, materials, tools, and equipment required for the complete and proper installation and termination of new horizontal “station” cabling as called for in these specifications and related drawings.

B. The horizontal portion of the telecommunications cabling system extends from the work area telecommunications outlet to the termination in the Telecommunications Room (TR).

C. This section includes minimum requirements and installation methods for the following:
   1. Copper Horizontal Cabling
   2. Fiber Optic Horizontal Cabling
   3. Work Area Faceplates
   4. Copper Modular Jacks
   5. Fiber Modular Jacks and Connectors
   6. Coaxial Horizontal Cabling

1.3 QUALITY ASSURANCE

A. All horizontal “station” cable installation and termination shall be performed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated shall be subject to the control of the Owner.

B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval of the Consultant and the Owner based on submittals provided.

C. Installations, materials, equipment and workmanship shall conform to the specifications and drawings and all applicable provisions of the most recent versions of the following regulations, codes, and standards including all applicable addenda:
   1. ANSI/NFPA 70 – National Electrical Code including, but not limited to, the following articles:
      a. 300 – Wiring Methods
      b. 645 – Information Technology Equipment

c. 725 – Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits
d. 770 – Optical Fiber Cables and Raceways
e. 800 – Communications Circuits
f. ANSI/TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
g. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
h. ANSI/TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standard
i. ANSI/TIA-568-C.3 – Optical Fiber Cabling Components Standard
j. ANSI/TIA-568-C.4 – Broadband Coaxial Cabling and Components Standard
k. ANSI/TIA-604 Series – Fiber Optic Connector Intermateability Standard
l. ANSI/TIA-606-B – Administration Standard for Commercial Telecommunications Infrastructure
m. ANSI/ICEA S-83-596 – Indoor Optical Fiber Cables
n. BICSI Telecommunications Distribution Methods Manual
o. BICSI Telecommunications Cabling Installation Manual

PART 2 - MATERIALS

2.1 EQUIPMENT AND MATERIALS REQUIREMENTS

A. Refer to Sheet Notes and Specification 27 06 00 Schedules for Communications for product data and part numbers.

2.2 INSTALLATION MATERIALS, EQUIPMENT, AND TOOLS

A. Furnish all required materials, equipment, and tools necessary to properly complete the horizontal copper UTP, coaxial CATV, and fiber optic cabling system installation including, but not limited to: tools for pulling and terminating the cables, mounting hardware, cable ties, bolts, anchors, clamps, hangers, kits of consumables, lubricants, communication devices, stands for cable reels, cable wenches, etc.

B. Poly line: poly pull line with a minimum pull tensile strength of 200 pounds.

PART 3 - EXECUTION

3.1 CABLES

A. Backbone and horizontal station telecommunications cabling shall be placed in separate dedicated pathways. Cable trays shall be clearly divided between backbone and horizontal station cabling.

B. Telecommunications pathways shall be dedicated for use for the Owner voice, data, CATV and AV cabling. Other services on the Owner's cables (intercom, audio, video, security, fire, BAS, DAS, etc.) may be placed in telecommunications pathways only with prior written approval from the Owner. Horizontal cabling for other services may be allowed within the Owner's pathways per the following guidelines and acceptance of written approval from the Owner. The Owner must understand and accept the services to be used on the Horizontal cabling as to not create interference with other services within the pathways. The Owner will be the sole owner of the

horizontal cabling with jacks on both ends that will be installed and tested per this Division 27 standard. Other terminations and systems can be reviewed by the Consultant but all Horizontal cabling for other services must be approved in writing from the Owner.

C. All horizontal cabling terminating within a single faceplate must be routed to and terminated in the same TR.

3.2 HORIZONTAL CABLING INSTALLATION

A. Install faceplates with UTP copper, coax and fiber jacks at each work area outlet location as indicated on the project drawings. Place the jacks in the faceplates beginning with position A and placing the copper jacks before the CATV coaxial and/or fiber adapter jacks. Place blank covers in the unused openings on each faceplate.

B. Faceplates shall be secured with mechanical fasteners. Adhesive fasteners shall not be allowed.

C. Install copper UTP, coaxial, and/or fiber optic horizontal cable from each work area outlet location indicated on the drawings to the TR designated on the project drawings.

D. Where any portion of the horizontal cable will be routed outside, or under slab, Outside Plant (OSP) rated cable shall be installed. OSP horizontal cabling shall be fully enclosed in conduit for the entire route from the outlet to the TR.

E. All horizontal cabling terminating within a single faceplate must be routed to and terminated in the same TR.

F. Install one back box and one Category 6 jack at each Wireless AP location.

G. Perform all horizontal cable installation in conformance with manufacturer's installation guidelines.

H. Ensure that maximum pulling tensions of specified cables are not exceeded and cable bends maintain the proper radius during placement.

I. The horizontal cable distribution system design uses conduit J-hooks for support from the outlet location to the TR or ER as shown on the project drawings. Coordinate as necessary with electrical contractor for placement of horizontal cable pathways and outlet boxes.

J. Horizontal telecommunications cabling shall be placed in dedicated pathways separate from backbone and other cabling.

K. All horizontal cables within the TRs shall be bundled with Velcro cable every 8 to 12 inches from the patch panels to the point where the cables exit the room. The Velcro cable ties shall hold, but not deform, the cables, and shall overlap a minimum of 2" to allow for more cable to be added in the future. Cable bundles shall have no more than 32 cables per bundle.

L. A small drip loop is required on the horizontal cables at the patch panel for trouble shooting and future changes. The drip loop on the horizontal cable should be approximately 2RU from the jack in the panel to the bottom of the loop.

M. The horizontal cabling routing from each jack on the back of the patch panels shall route to the nearest side of the panel and shall not cross the center line of the panel. The only exception is for

hinged swing-out wall racks, where the horizontal cabling will route from each jack to the hinged side of the panel to allow the rack to swing open for future installations and maintenance.

N. Install new Poly line in all conduits and cable trays while pulling in new horizontal cables.

O. Ceiling tile shall be removed as necessary for the cable installation and put back in place without damaging or dirtying any of the tiles or supporting framework. Ceiling tile shall be handled with clean hands so that no fingerprints or marks are left on the tiles. The contractor is responsible for the cost of repair or replacement of any damaged or dirtied tiles or ceiling hardware.

P. All cables in the ceiling space:

1. Shall be supported in conduit J-hooks at approved intervals;
2. Shall not be run “wild” (unsupported by conduit, J-hooks) for distances greater than four feet;
3. Shall not be attached to the suspended ceiling structure or laid directly on the ceiling grid as a means of support;
4. Shall not be supported by or attached by any means to fire sprinkler heads or delivery systems, any environmental sensor, or the exterior of any conduit or raceway;
5. Shall be routed at right angles to the electrical power circuits where the cable is not enclosed in conduit or in cable tray.

Q. Where specifically allowed by the Owner, J-hooks shall be specifically designed and installed for the purpose of supporting telecommunications cables. The J-hooks shall be attached to the building structure and framework at a maximum of four-foot intervals.

R. All cables in J-hooks shall be bundled with plenum rated Velcro cable ties every 8 to 12 inches. The Velcro cable ties shall hold, but not deform, the cables, and shall overlap a minimum of 2” to allow for more cable to be added in the future. Cable bundles shall have no more than 32 cables per bundle.

S. The total length of any horizontal station cable from the jack location at the outlet to the termination in the TR shall not exceed 295 feet. Where building or infrastructure conditions prohibit meeting this requirement, notify the Owner’s Construction Manager (CM) and Consultant immediately for resolution.

T. Dress and manage excess cable for the entire horizontal cable run to avoid excess cable kinking.

U. For copper UTP or coaxial cable in J-hooks or non-metal pathways, maintain the following clearances from EMI sources:

1. Unshielded power lines or equipment less than 5 kVA: 12”
2. Unshielded power lines or equipment equal to or greater than 5 kVA: 24”
3. Power lines enclosed in grounded metal conduit less than 5 kVA: 6”
4. Power lines enclosed in grounded metal conduit equal to or greater than 5 kVA: 12”
5. Fluorescent fixtures: 12”
6. Motors or transformers: 48”

V. For copper UTP or coaxial cable in grounded metal pathways (conduit), maintain the following clearances from EMI sources:

1. Unshielded power lines or equipment less than 5 kVA: 6”
2. Unshielded power lines or equipment equal to or greater than 5 kVA: 12”
3. Power lines enclosed in grounded metal conduit less than 5 kVA: 3”
4. Power lines enclosed in grounded metal conduit equal to or greater than 5 kVA:6”
5. Fluorescent fixtures: 6”

6. Motors or transformers: 36”

W. Do not splice or bridge tap the horizontal cable.

X. All cables shall be tied and dressed neatly with a minimum bend radius of 10 times the cable diameter. Provide necessary hardware to maintain proper bend radius at corners.

Y. All cables shall be firmly held in place. Fastenings and supports shall be adequate to support loads with ample safety factors.

Z. Failure to follow appropriate guidelines for cable installation will require the Contractor to provide, in a timely fashion, the additional material and labor necessary to rectify the situation. This shall apply to any and all damages sustained to the cables during installation.

AA. The Contractor shall be responsible for all damage to the cable during placement.

BB. Cables with jackets that are chaffed or burned exposing internal conductor insulation or have any bare copper (shiners) shall be replaced.

CC. Do not roll or store cable reels without an appropriate underlay.

DD. Firestop the insides of all sleeves through fire rated barriers with a UL approved system after cable installation is complete.

EE. Test, label and document final horizontal cable installation including outlet numbering on as-built drawings.

FF. Remove existing cable and terminations that will no longer be used as specified and shown on project drawings.

GG. Remove existing cable and terminations that will no longer be used as specified and shown on project drawings.

HH. Coordinate as necessary with electrical contractor for removal of existing horizontal cable pathways and outlet boxes.

II. A single gang vertical cover shall be installed for securing voice and data patch connections at such locations as kiosks, as shown on the project drawings.

3.3 COPPER CABLE TERMINATION

A. Terminate all pairs on both ends of the copper UTP horizontal cable on the jack with TIA T568B pin-pair assignments per manufacturer’s guidelines.

B. With prior written approval from Owner only, match existing termination practice for horizontal cables to110-type blocks.

C. All cables shall be terminated with proper strain relief to the terminating equipment.

3.4 COAXIAL HORIZONTAL CABLING

A. All drops shall be home-run from the distribution tap to the face plate, with no drop splitters or amplifiers to be used. Variations of this requirement shall be made only with express written approval from the Owner, CATV Operations.

B. Terminate both ends of the coaxial cable on F-connectors.

C. At the work area outlet, place the terminated coaxial cable in the F-connector pass-through in the faceplate.

D. All F-connectors being attached to distribution taps and pass-through in the faceplate shall be tightened to 20-30 inch pounds measured with a torque wrench intended for this purpose.

E. All cables shall be terminated with 6” - 12” slack at the distribution tap so as not to pull tight on the terminating equipment.

F. Label all coaxial terminations according to the Owner’s standards. This will be a double-sided “flag” label at the distribution tap.

END OF SECTION 271500

SECTION 27 60 00 - TELEVISION DISTRIBUTION SYSTEMS

PART 1- GENERAL

1.1 SUMMARY

A. This Section includes requirements for installation of the RF distribution and system for Television (TV) signal distribution.

1.2 SUBMITTALS

A. Provide submittal information for the following:
   1. Product Data
   2. Equipment list, based upon specified equipment list and other additional equipment or materials needed for a complete system.
   3. Shop Drawings: Submit shop drawings showing the ratings of items and systems and how the components of an item or system are to be assembled, interconnected, function together and how they will be installed on the project. System layout drawings shall show floor plans with complete device layout and point-to-point wiring and connection diagrams between all components of the system.

1.3 RECORD DOCUMENTS

A. Provide the following:
   1. System component labels and identifiers for all major components, including engraved, silk screen, and paper labels.

1.4 SYSTEM DESCRIPTION

A. The TV service provider shall be responsible for providing and installing all source equipment to provide signal to the campus.

B. Cabling from the Dining Building is required to provide signal to the building. Coordination with the Owner will be required to gain access to the basement IDF Room to install the amplifier and connect the related cabling.

C. The Television Distribution system shall be a new system and provide television distribution signal from the active components to each of the locations identified on the Technology drawings. Include all other equipment and incidental materials necessary for a complete and fully functional TV distribution.

D. Meet all FCC requirements regarding low radiation of RF signal.

PART 2 - MATERIALS

2.1 GENERAL

A. Manufacturer: Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications. Each major component of equipment shall identify the manufacturer’s name, model and serial number. Items of the same classification shall be identical. This includes equipment, modules, parts, and components. The Engineer retains the right to

reject products which reflect, in the Engineer's opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

B. Part Numbers: Part numbers listed define the performance specifications for the parts and shall be per the most recent manufacturer's cut/data specification sheets available at the time of bid.

C. Provide materials in quantities as required to provide a fully functional and operational TV System.

2.2 EQUIPMENT SPECIFICATIONS

A. Cabling
   1. All cabling shall consist of RG-6 and RG-11 coaxial type cabling.

   2. Install RG-6 cabling for runs 150' or less and RG-11 cabling for cable runs exceeding 200'.

   3. All coax cabling shall be terminated on barrel style F-connectors at the faceplates and F-Connector inserts on the head end side.

   4. Manufacturer: CommScope or approved equal
      a. RG-6 – 5730
      b. RG-11 – 5916

B. Splitters, Directional Couplers, Amplifiers
   1. Manufacturer:
      a. Blonder-Tongue

      b. Or approved equal

PART 3 - EXECUTION

3.1 GENERAL

A. Governing Requirements of particular relevance to this Section include, but are not limited to:
   1. NFPA 70: National Electrical Code as adopted and amended by the Local Jurisdiction

3.2 INSTALLATION

A. Cabling:
   1. The cabling shall meet all standards and manufacturer's requirements.
   2. The cabling shall not exceed manufacturer's bend radius and be installed in conduits, cable-slings, or cable tray.

B. Equipment:
   1. Equipment shall be installed as indicated and specified, and in accordance with the manufacture's recommendations, except where local codes or regulations take precedence.
   2. Place equipment labels or other identification where the label or identification can be easily seen and read without difficulty.

3. Equipment shall be installed level, plumb, parallel, and perpendicular to building structures and to other building systems and components, except where otherwise indicated.
4. Equipment shall be securely fastened. Select fasteners and supports so that the load applied to any one fastener maintains a minimum load factor of 5.
5. Equipment locations: Prior to installation of TV System equipment, Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount on walls or within ceilings. This shall include but not be limited to:
   a. Structural elements such as lighting devices, HVAC equipment, fire protection devices, and cable tray
   b. Structural support elements for ceiling mounted devices
   c. Backing Board for wall mounted devices
6. Prior to head-end equipment installation, Contractor shall verify equipment rooms are free of airborne contaminants.
7. After head-end equipment installation, Contractor shall protect equipment from any future construction work that could cause damage to equipment, i.e. masonry, wood, paint, plumbing, etc.
8. Prior to furniture work, Contractor shall coordinate with other trades and subsequently verify all equipment locations that mount within furniture,
9. Contractor shall coordinate with architect as to any equipment color and finish requirements.

3.3 TESTING

A. Testing of system shall include continuity, signal strength, and labeling.

END OF SECTION 27 60 00

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SECTION 28 31 11 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SUMMARY:

A. Provide system suitable for type and occupancy as defined by local Building Code,, as approved by local Fire Marshal, and local authority having jurisdiction. Drawings indicate general design intent and do not indicate all equipment or devices or the full extent of the System. Provide complete design of the Fire Alarm System.

B. Provide an Analog/Addressable System which is defined as a system in which initiating devices and interface modules transmit their address via a binary or multiplex code over a common pair of wires. This address is converted to an English language display giving a custom description for each reporting device. In addition, the system will provide analog information about the sensitivity of each photoelectric, and heat sensing device. The system control panel will maintain a log of this information which can be reviewed on demand. The system will also provide a maintenance alert when the sensitivity of any detector has been outside of a preset range for a period of 24 hours.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire alarm systems of types, sizes, and electrical characteristics required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with fire alarm systems work similar to that required for this project.

1. Firm with manufacturer's factory trained personnel.
2. Firm with factory authorized service organization and spare parts stock within 50 miles of the project and with a 24 hour response time.
3. Installation shall be accomplished by or supervised by NICET II or higher.

C. Codes and Standards

1. Each and every item of the fire alarm system shall be listed as the product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratory, Inc. (UL) and shall bear the UL label on all devices, appliances and panels comprising the system. All control equipment shall be listed under the category UOJZ as a single control unit and cross listed with the base loop fire alarm system. Partial listings shall be unacceptable.

2. The complete installation shall conform to the applicable sections of NFPA and Local Code Requirements, and the National Electrical Code with particular attention to article 760. All control equipment must have transient protection to comply with UL 864 requirements or Standard #497B as applicable.

3. FM Compliance: Provide fire alarm systems and accessories which are FM approved.

4. The fire alarm system and devices shall comply with ADA 1990 and UL 1971 requirements.

1.3 SUBMITTALS:

A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

B. Product Data: Submit manufacturer's technical product data including specifications, data sheets, wiring diagrams, equipment ratings, dimensions, finishes, and description of system operation.

C. Shop Drawings: Provide shop drawing submittal for approval by the local Fire Department and/or The Authority having jurisdiction. The Contractor shall arrange to have the Fire Alarm System shop drawing submittal prepared, sealed, and signed by a professional engineer and NICET III or NICET IV in Fire Alarm Systems if/as required by the authority having jurisdiction. Preparer shall assume the duty of Engineer of Record for the Fire Alarm System design. Provide shop drawings showing system components, including panels and cabinets, locations, quantities, and full schematic of system wiring showing conductor routings and quantities, and connection details. Provide updated room names and numbers that match the names and numbers as labeled at the building. Room names and numbers shown on the contract documents are not necessarily those that are currently being used in the building. The fire alarm manufacturer shall coordinate with the contractor and owner on existing and new work and survey the site on existing work to identify the proper names and numbers. All conduit routing must be submitted to, and accepted by, the Architect/Engineer. Shop drawing documents must be submitted simultaneously with sprinkler system documents and prior to installation.

This information shall be submitted on 1/8 inch = 1foot scale building floor plans. No other systems shall be included on these plans. Reproduction of contract drawing will not be acceptable. The following information shall be included in the shop drawings:

1. Occupancy group and use.
2. Number of stories.
3. Indicate extent of building sprinkler system.
4. Indicate addition to/modifications of existing system.
5. One-line diagram showing/indicating number of devices and appliances per zone/circuit.
6. Wire sizes, color coding, type(s) and voltage drop calculations.
7. Indicate annunciation method and include graphic zone map.

D. Submit manufacturer's installation instructions, including outlet or back box requirements for each piece of equipment.

E. Submit manufacturer's certificate that system meets or exceeds specified requirements.

F. Submit sequence of operation and verification of system operation by manufacturer or his authorized representative.

G. Submit back-up battery calculations.

H. All shop drawings, battery and voltage drop calculations shall be submitted to the authority having jurisdiction for review after review by the Architect/Engineer.

I. Submit graphic annunciator and/or map layouts for review by the Architect/Engineer prior to fabrication.

J. Indicate whether fire alarm system is required or non-required and list code sections required by and applicable to.

K. List all variances and attach as required.

L. Include brief description of scope of work.

M. Submit Zone schedule.

N. Submit device address schedule.

O. Submit interior and exterior front elevations of the FACP and exterior front elevations of other panels.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Handle fire alarm equipment carefully to prevent damage, breaking, and scoring. Do not install damaged equipment or components; replace with new.

B. Store fire alarm equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

1.5 EXTRA MATERIALS:

A. General: Provide extra materials as listed below in addition to that required to complete the work. The additional stock shall not be used unless specifically authorized by the Owners Representative.

B. Lamps: Furnish spare/replacement lamps and LED’s amounting to not less than three (3) lamps of each type and of each color.

C. Devices:

1. Furnish spare/replacement detection bases amounting to 5 percent of the quantity installed by this work, but not less than two (2) of each type, including duct detector housings.

2. Furnish spare/replacement detectors amounting to 5 percent of the quantity installed by this work, but not less than two (2) of each type.

3. Furnish spare/replacement adaptor modules and relays amounting to 5 percent of the quantity installed by this work, but not less than one (1) of each type.

4. Furnish spare/replacement speakers/horns, combination speaker/horn/strobe units, and strobe units amounting to 5 percent of the quantity installed by this work but not less than one (1) of each type.

D. Provide an additional spare/replacement addressable device communication card in the FACP which can be programmed for connection to future initiating devices.

1.6 OPERATION:

A. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:

1. All audible alarm indicating appliances shall sound a distinctive and continuous fire alarm signal until silenced by the alarm silence switch at the control panel or at the remote annunciator.

2. All visible alarm indicating appliances shall flash continuously until the system is reset. Visual alarm devices shall continue to operate when audible devices are silenced, when allowed by the AHJ. Any subsequent zone alarm shall reactivate the alarm indicating appliances.

3. All doors normally held open by door control devices shall release.

4. A supervised signal to notify the monitoring center shall be activated. Signal shall indicate separately, a fire detector zone in alarm, fire alarm system trouble, sprinkler tamper (supervisory), sprinkler flow or individual alarm point address and description, including system troubles and other monitored signals.

5. Activation of a sprinkler flow device shall cause the exterior horn/light to operate continuously until the flow has ceased.

6. Activation of a duct detector shall alarm the system and shut down the associated air handling unit.

B. The alarm shall be displayed on an 80 character LCD display. The top line of 40 characters shall be the point label and the second line shall be the device type identifier. The system alarm LED shall flash on the control panel and the remote annunciator until the alarm has been acknowledged. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone shall flash the system alarm LED on the control panel and remote annunciator. The LCD display shall show the new alarm information.

C. A pulsing alarm tone shall occur within the control panel until the event has been acknowledged.

D. The activation of any system addressable smoke detector shall initiate an Alarm Verification operation whereby the panel will reset the activated detector and wait for a second alarm activation. If within one (1) minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described previously. If no second alarm occurs within one minute the system shall resume normal operation. The Alarm Verification shall operate only on addressable smoke detector alarms. Other activated initiating devices shall be processed immediately. The alarm verification operation shall be selectable by zone.

1. The control panel shall have the capability to display the number of times (tally) a zone has gone into a verification mode. Should this mode verification tally reach a pre-programmed number, a trouble condition shall occur.

E. The control panel shall have a dedicated supervisory service LED and a dedicated supervisory service acknowledge switch.

1. The activation of any standpipe or sprinkler valve supervisory (tamper) switch shall activate the system supervisory service audible signal and illuminate the LED control panel and the remote annunciator. Differentiation between valve tamper activation and opens and/or ground on the initiation circuit wiring shall be provided.

2. Pressing the Supervisory Service Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory Service LED "ON" indicating the off-normal condition.

3. Restoring the valve to the normal position shall cause the Supervisory Service LED to extinguish, indicating restoration to normal.

F. A manual evacuation (drill) switch shall be provided to operate the alarm indicating appliances without causing other control circuits to be activated. However, should a true alarm occur, all alarm functions would occur as described previously.

G. The system shall have a single key that will allow the operator to display all alarms, troubles, and supervisory service conditions including the time of each occurrence.

H. The actuation of the "enable walk test" program at the control panel shall activate the "Walk Test" mode of the system which shall cause the following to occur:

1. The city circuit connection shall be bypassed.
2. Control relay functions shall be bypassed.
3. The control panel shall show a trouble condition.
4. The alarm activation of any initiation device shall cause the audible signals to code a number pulses to match the zone number.
5. The panel shall automatically reset itself after signaling is complete.
6. Any momentary opening of an initiating or indicating appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating a trouble condition.
7. The system shall have the capacity of 8 distinctive walk test groups. Such that only a portion of the system need be disabled during testing.

1.7 SUPERVISION:

A. There shall be supervisory service initiation device circuits for connection of all sprinkler valve supervisory switches (tamper). Device activation shall cause a supervisory alarm at the control panel.

B. There shall be independently supervised and independently fused indicating appliance circuits for alarm speakers and flashing alarm lamps. Disarrangement conditions of any circuit shall not affect the operation of other circuits.

C. Auxiliary manual control shall be supervised so that an "off normal" position of any switch shall cause an "off normal" system trouble.

D. Each independently supervised circuit shall include a discrete LCD readout to indicate disarrangement conditions per circuit.

E. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel and the remote annunciator. A green "power on" LED shall be displayed continuously while incoming power is present.

F. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel.

G. The System Modules shall be electrically supervised for module placement. Should a module become disconnected the system trouble indicator shall illuminate and the audible trouble signal shall sound.

H. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide fire alarm systems by the following:

1. Simplex
2. Siemens
3. Notifier
4. Johnson Control, Autocall
5. EST
6. H.R. Kirkland Co, Inc. - Graphic/Directory Annunciators and Maps.

B. Fire Alarm Cable

1. West Penn
2. Belden
3. Annixter

2.2 FIRE ALARM AND DETECTION SYSTEMS:

A. General: Provide complete fire alarm products of types, sizes and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated.

B. Wiring System Materials: Provide basic wiring materials which comply with Division-26 sections; "Raceways", Wires and Cables" and "Electrical Boxes and Fittings".

1. Provide wire and cable in accordance with requirements of manufacturer. Wire insulation shall comply with NEC Article 760.

2. Provide individual solid copper conductor sizes AWG #14, or larger.

3. Provide multi-conductor cables for wire sizes smaller than AWG #16.

4. Provide conductors which are UL listed for the installation and location, and approved for fire alarm usage.

5. Initiating circuits shall be color coded red for positive, red with black stripe for negative. Indicating circuits shall be color coded red with yellow stipe for positive, red with brown stripe for negative.

6. All conductors shall be numbered and their numbers shall correspond to the terminal block numbering they are connected to. Provide conductor wiring and terminal block numbering.

7. Wiring styles shall be as follows: Class B-IDC, Class B, Style 4-SLC, Class B-NAC. Style D-IDC between buildings.

8. Provide multiple audible zones and alternate zones per floor.

C. Power Requirements:

1. The control panel shall receive 120 VAC power via a dedicated circuit. The system shall include an integral, transient voltage surge suppression device (SPD) on the incoming 120- volt power. SPD device shall be UL 1449 rated for 380 volts/Type B.

2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 4 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.

3. All external circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

2.3 FIRE ALARM CONTROL PANEL:

A. Control Panel construction shall be modular with solid state, microprocessor based electronics that are compatible with current codes and current UL requirements. It shall display only those primary controls and displays essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm condition.

B. A local audible device shall sound during Alarm, Trouble or Supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition from another without having to view the panel. This audible device shall also sound during each keypress to provide an audible feedback to ensure that the key has been pressed properly.

C. The following primary controls shall be visible through a front access panel:

1. Eighty character liquid crystal display
2. Individual red system alarm LED
3. Individual yellow supervisory service LED
4. Individual yellow trouble LED
5. Green "power on" LED
6. Alarm acknowledge Key
7. Supervisory Acknowledge Key
8. Trouble Acknowledge Key
9. Alarm Silence Key
10. System Reset Key

D. The following secondary control switches and LED's shall be available behind an access door:

1. City disconnect/switch
2. Manual evacuation (drill)
3. Elevator bypass
4. Door holder release bypass
5. Smoke damper control switches

E. The control panel shall provide the following:

1. Setting of time and date
2. LED testing

3. Alarm, trouble, and abnormal condition listing
4. Enabling and disabling of each monitor point separately
5. Change in operator access levels
6. Walk Test enable and disable
7. Running diagnostic functions
8. Displaying software revision level
9. Displaying historical logs
10. Displaying card status
11. Point listing

F. For maintenance purposes the following lists shall be available from the point lists menu.

1. All points list by address
2. Monitor point list
3. Signal/speaker list
4. Auxiliary control list
5. Feedback point list
6. LED/switch status list
7. Device sensitivity points list

G. Scrolling thru menu options or lists shall be accomplished in a self-directing manner in which prompting messages shall direct the user. These controls shall be located behind an access door.

H. The Control Panel shall have a 2 line x 40 character liquid crystal display which shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there is keypad activity.

2.4 SYSTEM FRONT PANEL OPERATION AND CAPABILITIES:

A. Under normal condition the front panel shall display a "System is Normal" message and the current time and date.

B. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The panel audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory condition.

C. The LCD shall display the following information relative to the abnormal condition of a point in the system.

1. 40 character custom location label
2. Type of device (i.e., smoke, pull station, water flow)
3. Point status (i.e., alarm, trouble)

D. Pressing the appropriate acknowledge button shall globally acknowledge every point in the list. These acknowledge functions may be pass code protected if the user has insufficient privilege to acknowledge such conditions. A message shall indicate insufficient privilege but allow the user to view the points without acknowledging them. Should the user have sufficient privilege to acknowledge, a message will be displayed informing the user that the condition has been acknowledged.

E. After all points have been acknowledged, the LED's shall glow steady and the audible alarm will be silenced. The total number of alarms, supervisory and trouble conditions shall be

displayed along with a prompt to review each list chronologically. The end of the list shall be indicated by an end of list message "END OF LIST."

F. Alarm Silencing: Should the "Alarm Silence" button be pressed, all audible alarm signals shall cease operation.

1. Signals shall not be silenced during alarm silence inhibit mode.

G. System Reset: The SYSTEM RESET button shall be used to return the system to its normal state after an alarm condition has been remedied. The LCD display shall step the user thru the reset process with simple English Language messages.

1. Should an alarm condition continue to exist the message, "SYSTEM RESET IN PROGRESS" will be followed by the message "SYSTEM RESET ABORTED", and the system will remain in an abnormal state.

2. Should the Alarm Silence Inhibit function be active, the "SYSTEM RESET" key press will be ignored. The message, "SYSTEM RESET INHIBITED" will be displayed for a short time to indicate the action was not taken.

H. History Logging: The system shall be capable of logging and storing 300 events in an alarm log and 300 events in a trouble log. These events shall be stored in a battery protected random access memory. Each recorded event shall include the time and date of that event's occurrence.

I. Silent Walktest with History Logging (Field Selectable): The system shall be capable of being tested by one person. While in testing mode the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. The panel shall automatically reset itself after logging of the alarm. The momentary disconnection of an initiating or indicating device circuit shall be silently logged as a trouble condition in the historical data file. The panel shall automatically reset itself after logging of the trouble condition. After testing is considered complete, testing data may be retrieved from the system in chronological order to ensure device/circuit activation.

1. Should the walk test feature be on for an inappropriate amount of time, it shall revert to the normal mode automatically.

2. The control panel shall be capable of supporting up to 8 separate testing groups whereby one group or points may be in a testing mode and the other (non-testing) groups may be active and operate as programmed per normal system operation.

3. Should an alarm condition occur from an active point, not in walk test mode, it shall perform operations described in Paragraph 1.6.

J. LED Supervision: All slave module LED's shall be supervised for burnout or disarrangement. Should a problem occur, the LCD shall display the module and LED location numbers to facilitate location of that LED.

K. System Trouble Reminder: Should a trouble condition be present within the system and the audible trouble signal silenced, the trouble signal shall resound at preprogrammed time intervals to act as reminder that the fire alarm system is not 100% operational. Both the time interval and the trouble reminder signal shall be programmable to suit the Owner's application.

L. Access Levels: There shall be four (4) access levels with level 4 being the highest level. Level 1 actions shall not require a passcode. Changes to passcodes shall only be made by authorized personnel. Access to a level will only allow the operator to perform all actions within that level plus all actions of lower levels, not higher levels. All keys, switches, and buttons shall have levels associated with them.

M. RS-232-C Output: Fire Alarm Control Panel shall be capable of operating remote CRT's and/or printers; output shall be ASCII format and EIA RS-232-C connection with an adjustable baud rate.

N. Auxiliary Devices:

1. Fire alarm auto dialer, call box, serial line, etc., and connections shall be coordinated and provided per owner requirements for interface to monitoring company or local fire department. Monitoring company shall be UL Listed. Provide one year of monitoring service with system.

2. Smoke Control: Where required or indicated the fire alarm panel shall be provided with "OPEN/CLOSE/AUTO" switches to allow manual operation of the exhaust smoke dampers on each floor.

O. Equipment Enclosures: Provide cabinets of sufficient size to accommodate the aforementioned equipment. Cabinet shall be equipped with locks and transparent door panel providing freedom from tampering yet allowing full view of the various lights and controls.

2.5 ADDRESSABLE COMMUNICATION NETWORK:

A. The system must provide communication with addressable initiating and control devices individually. Each of these devices will be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:

1. Alarm
2. Trouble
3. Open
4. Short
5. Device missing/failed

B. All addressable devices shall have the capability of being disabled or enabled individually.

C. Systems that require factory reprogramming to add or delete devices are unacceptable.

D. The communication format must be a completely digital poll/response protocol to allow t-tapping of the circuit wiring.

E. Each addressable device must be uniquely identified by an address code entered on each device at time of installation. The use of jumpers to set address will not be acceptable. Device identification schemes that do not use uniquely set addresses but relay on electrical position along the communication channel are unacceptable.

F. There shall be no limit to the number of detectors, zone adapter modules, or stations which may be activated or "IN ALARM" simultaneously.

G. All devices shall be supervised for trouble conditions. The system control panel will display the type of trouble condition in plain English. Should any device fail, it will not prevent the operation of other devices.

H. Spare capacity shall be provided to allow for 20 percent more addressable points to be added to the fire alarm system without adding additional components after system is complete.

2.6 ADDRESSABLE DEVICE TYPES:

A. General: Devices will be located as shown on the drawings. The location of addressable devices will be selected to optimize the system layout in order to provide the level of protection, zone identification and control as shown on the drawings.

B. Environmental Compensation Analog Sensors:

1. Smoke sensors shall be a smoke density measuring device having no self-contained alarm set point. The alarm decision for each sensor shall be determined by the control panel. The control panel shall determine the condition of each sensor by comparing the sensor value to stored values. The control panel shall maintain a moving average of the sensors smoke chamber value. Systems that do not automatically maintain a constant smoke obscuration sensitivity for each sensor by compensating for environmental factors are deemed unacceptable.

2. The detector shall automatically indicate when an individual sensors needs cleaning. When a sensor's average value reaches a predetermined value, a "Dirty Sensor" trouble condition shall be audibly and visually indicated at the control panel. Additionally, the LED on the sensor base shall glow steady giving a visible indication at the sensor location. If a "Dirty Sensor" is left unattended, and its average value increases to a second predetermined value, an "Excessively Dirty Sensor" trouble condition shall be indicated at the control panel for the individual sensor.

3. The control panel shall automatically perform a daily self-test on each sensor. Checking the electronics in the sensor's base ensures the accuracy of the values being transmitted to the control panel. A sensor that fails the self-test will cause a "Self-Test Abnormal" trouble condition at the control panel. A sensor self-test which must be manually initiated by the operator shall not be acceptable.

C. Addressable Detector Bases: All addressable smoke and heat detector heads will plug into their bases. The base will contain electronics that communicate the detector status (normal, alarm, trouble) to the control panel over two wires. The same two wires shall also provide power to the base and detector. Detector heads (smoke or heat) must be interchangeable. Upon removal of the head, a trouble signal will be transmitted to the control panel.

1. Carbon Monoxide (CO) sensor bases: Where indicated or required provide multi-point addressable CO sensor bases with CO sensing module providing CO toxic gas monitoring. Listed to UL 268 Smoke Detectors for Fire Alarm Signaling Systems and UL 2075 Gas and Vapor Detectors and Sensors (allowing systems to be listed to Standard 2034, Single and Multiple Station Carbon Monoxide Alarms shall be Listed by ULC to CSA 6.19-01. Residential Carbon Monoxide Alarming Devices shall be one of three types of CO influenced operation as follows: UL 2034 CO alarm detection; UL 2075 CO (OSHA) level monitoring for ventilation control; and multi-criteria fire sensor analysis with algorithms that combines optical and CO gas monitoring information. Provide control panel modifications necessary to monitor and alarm CO sensors. Provide piezoelectric sounder where required.

D. Photoelectric Detector Head: Photoelectric type detectors shall be of the solid state photoelectric type and shall contain no radioactive material. They will use a pulsed infrared LED light source and be sealed against rear air flow entry. The detector shall fit into an addressable base that is common with both the heat and photoelectric type detectors.

E. Thermal Detector Head: Thermal detector heads must be UL listed. They will be a combination rate-of-rise and fixed temperature (135 degrees F) type, automatically restorable unless fixed temperature (190 degrees F.) type are specifically required. The detector shall fit into an addressable base that is common with both the photoelectric and ionization type detectors. Provide addressable module for automatic restoring detectors that are not addressable.

F. Pull Stations: Pull stations shall contain electronics that communicate the station's status (alarm, normal) to the control panel over two wires which also provide power to the pull station. The address will be set on the station. They will be manufactured from high impact red Lexan. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations will be single/double action. The front of the station is to be hinged to a back-plate assembly and must be opened with a key to reset the station. The key shall be common with the control panels. The addressable manual station shall be Underwriters' Laboratories Inc. listed for operation with the control panel.

G. Duct Smoke Detectors: The detector shall be non-polarized 24VDC type which is compatible with the fire alarm panel and obtains its operating power from the supervisory current of the addressable loop. The detector head shall be the same as the addressable photoelectric detector heads used in the rest of the system. Provide duct detectors compatible with the air velocities within the duct to be installed (i.e. for low velocity ducts, provide an in-duct style detector). It shall be possible to test the detector by use of a remote alarm test switch. The duct detector housing shall contain the addressable electronics necessary to communicate with the control panel. For maintenance purposes, it shall be possible to clean the sampling tubes by access through the detector housing. To minimize false alarms, voltage and transient suppression techniques shall be employed as well as automatic alarm verification circuitry and insect screens.

1. Each duct detector shall be provided with a remote alarm LED indicator and a Magnet Type RTS. Plates shall be labeled with the name of the device/equipment served.
2. Interlock each fan with its associated duct detector.
3. Provide access door(s) for in-duct style duct detectors.

H. Adaptor Module: Adapter Modules shall be used for monitoring of water flow, valve tamper, non-addressable detectors, and for control of smoke dampers, door holders, and other output control functions. Adapter Modules will be capable of mounting in a standard electric outlet box. Adapter Modules will include cover plates to allow surface or flush mounting. Adapter Modules will receive their 24VDC power from a separate two wire pair running from an appropriate power supply. There shall be two types of devices: Type 1; Monitor Adapter Modules - for conventional 2-wire thermal detector and/or contact device monitoring with Class B or Class A wiring supervision. Type 2; Control Adapter Modules - for signals, speakers, fire fighter phone jacks and other device control with Class B or Class A wiring supervision.

1. Air Handling Equipment: Provide modules as required for monitor and control of Air Handling units such that the unit shall shut down upon detection of smoke at the unit or from any detector alarm within the space. Provide relays as required.

2. Provide modules as required to monitor existing hardwired zones. Existing zone quantities and configurations shall remain, unless otherwise indicated or shown on the plans.

2.7 ALARM SIGNAL DEVICES:

A. Fire Alarm Horn/Strobe Combination: Provide high impact resistant red LEXAN Horn/strobe combination devices as shown on the plans. Each assembly shall consist of two independent devices which are manufactured as compatible with each other and with the control equipment. Each assembly shall provide a terminal strip or wire leads for true in-out wiring connections. The strobe unit shall have a candela-second rating in compliance with ADA requirements and be rated at 24 VDC. Strobes shall be clear with red letters "FIRE" on two sides.

1. Provide wall mounting as shown on the plans. Verify manufacturer mounting requirements prior to rough in.

B. Individual Strobe Unit: Provide strobe units mounted where shown. Units shall match those used in the combination horn/strobe or speaker/strobe specified.

C. Where multiple strobe units are visible from a single location and the potential visible flash rate is 5 hz or more, provide synchronizing modules and strobes compatible for synchronizing as required. Provide additional wiring, conduit, and power supplies as necessary.

D. Speakers/Horns have been located on the drawings. It is the Contractor's responsibility to provide adequate coverage to achieve the required 15 dBA above ambient at all locations throughout the building. If locations shown are inadequate, provide additional speakers/horns on shop drawing submittal. Additional speakers/horns will be added at no additional cost to the contract including conduit wiring, power supplies, etc. System shall meet NFPA 72 Intelligibility Standards required by AHJ.

2.8 AUXILIARY DEVICES/EQUIPMENT:

A. Magnetic Door Holder Devices: Provide door holders as shown on the plans. Release of doors occurs on a verified alarm or after a general AC power failure in the building. Coordinate all door hardware with door hardware supplier if applicable.

2.9 DIRECTORY ANNUNCIATOR:

A. General: The annunciator shall consist of a display with LEDs to indicate alarm status of the fire alarm system including location of devices in alarm. The annunciator shall be Underwriters Laboratory listed. Mounting location shall be approved by the local Fire Marshall or the authority having jurisdiction.

1. The annunciator shall communicate with the control panel via one twisted shielded pair of wires. Operating power shall be 24 VDC and shall be fused at the control panel.

B. Display: The display shall be a black image on a white, 1/8 inch acrylic backing with ultraviolet coating.

2.10 GRAPHIC MAP:

A. The graphic map shall be a full color image on a white background mounted on a rigid backing and shall have an ultraviolet inhibitor laminated on the front. Provide a clear, anti-glare,

LEXAN panel cover and mount map within a black anodized aluminum frame. Provide a concealed secured hanging system. Location of map shall be approved by the local Fire Marshall or the authority having jurisdiction. The graphic map shall include, but not be limited to, the following information:

1. Building outline, including address and adjacent streets.
2. All exterior doors.
3. Fire alarm control panel.
4. Sprinkler control valves.
5. Utility controls (electrical, natural gas, water).
6. Fire department connection.
7. Main area separations.
8. Compass direction reference (orient the map).
9. Map location ("YOU ARE HERE" with arrow).
10. Map location, fire alarm control panel, sprinkler valves and Fire Department connections must be highlighted in RED.
11. Zone area separations and designations.
12. Room names and numbers as labeled in the building.
13. Each duct detector; indicate HVAC unit designation and function (i.e., supply or return).
14. Legend of devices and other symbology.
15. Location of all individual devices.
16. Each fire detection and alarm device with addresses at each addressable device.

B. Provide building zone map showing each floor at each remote annunciator and include essential escape information unless otherwise specified.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which fire alarm systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 IDENTIFICATION:

A. Provide electrical identification in accordance with Division-26 section on Electrical Identification. SLC and NAC Devices shall be labeled with System Device Address and EOL locations shall be identified at each EOL device.

3.3 INSTALLATION OF BASIC WIRING SYSTEM MATERIALS:

A. Install all wiring in raceways.

B. Install wiring, raceways, and electrical boxes and fittings in accordance with Division 26 sections; “Raceways”, “Wires and Cables”, and “Electrical Boxes and Fittings”.

C. Install wiring in exposed ivory colored surface metal raceway where specifically noted as allowed on wall or ceilings.

D. Install wires and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals. Make soldered splices in electronic circuits in control cabinets.

3.4 INSTALLATION OF FIRE ALARM SYSTEMS:

A. Install fire alarm system as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation."

B. Wiring: Wiring of fire alarm system is not specifically detailed on drawings. Refer to the manufacturer's shop drawings for detailed wiring and connection information.

1. Complete wiring in accordance with manufacturer's requirements. Provide Striped Color coded wiring and install per manufacturer's point-to-point wiring diagram. Determine exact number of wires for each fire area zone from number and types of devices installed. Connect each device with sufficient wiring to complete its intended operation.

2. Where there are a number of power requiring devices such as smoke detectors, fan relays, door holders and smoke damper operators installed in a circuit, group in numbers so power required does not exceed 80 percent of manufacturer's power supply rating. Provide extra wiring, or extra power supplies required to fulfill that requirement. In addition, provide extra or larger size wiring to alleviate voltage drops which makes device operate beyond voltage limits for which it was designed. Determine above with manufacturer's representative while equipment is being installed.

3. Where an existing system is present it shall remain in operation while the new system is being installed, tested, and accepted.

4. Mount audible and visual devices per Americans with disabilities Act (ADA) 1990 requirements.

5. SLC T-Tapping is acceptable, IDC and NAC T-Tapping is not allowed.

3.5 FIELD QUALITY CONTROL:

A. Connection and Supervision: Make connections to panel under manufacturer's supervision. Run wiring to main terminal cabinet located adjacent to main fire alarm panel. Complete connections from this cabinet to panel utilizing Manufacturer's technicians.

B. System Test and Approval: Submit shop drawings for function and operation only, pre-approved by authority having local jurisdiction.

1. Prior to final acceptance of system, manufacturer shall, in presence of Contractor and Owner's Representative, test each sensing or detection and alarm device including devices and equipment interlocks such as equipment shutdown and smoke dampers. Schedule test with Owner prior to testing.

2. The completed fire alarm system shall be fully tested in accordance with NFPA-72 by the contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of a successful test, the contractor shall so certify in writing to the owner and general contractor.

3. The contractor shall coordinate the testing of each fire alarm detector added or relocated under this project with the fire department and forward a completed checklist showing each detector operated properly and that proper indication of detector operation occurred at all control panels, annunciator panels, remote indicators, remote test switches, etc. In addition, proper interlocks, door release, etc. shall be documented with specific equipment affected listed by identifier.

4. Submit copy of test results in duplicate after signed by Owner's Representative to Architect/Engineer, Owner, and local Fire Protection Authority. Mount copy of inspection record in Lexan enclosed frame assembly on control panel.

5. Provide Record of Completion Documentation per NFPA-72.

3.6 MAINTENANCE CONTRACT:

A. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72 guidelines.

3.7 WARRANTY:

A. The Contractor shall guarantee all equipment and wiring free from inherent mechanical and electrical defects for a period of one year from the date of acceptance as set forth in the general conditions.

3.8 OPERATING AND MAINTENANCE INSTRUCTIONS:

A. On completion of the work, the equipment manufacturer shall provide training for two maintenance personnel to a level equal to a "Factory-Certified Technician". The training shall be conducted at the vendor's local office or the Factory.

3.9 PAINTING AND PATCHING:

A. Contractor shall paint all exposed conduit to match adjacent surfaces. All surfaces or finishes damaged as a result of this work shall be properly patched, painted and/or repaired by trained craftsmen of the trade involved.

B. Blank plates shall be painted to match adjacent surfaces.

END OF SECTION 283111

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing existing vegetation.
2. Clearing and grubbing.
3. Removing above- and below-grade site improvements.
4. Disconnecting, capping or sealing, protecting and abandoning site utilities in place.
5. Temporary erosion and sedimentation control measures.

B. Related Sections:

1. Division 01 Sections
2. Division 31 “Earth Moving”.
3. Idaho Standards for Public Works Construction, Current Edition.
4. Geotechnical Investigation and Addenda as prepared by Atlas Technical Consultants, LLC, File Number: T211194g.
5. SWPPP Documents.

1.2 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. 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.

C. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site. Conform to applicable code for disposal of debris.

1.4 SUBMITTALS

A. Operations & Maintenance Data: Submit Record Drawings identifying and accurately showing locations of utilities and other subsurface structural, electrical, and mechanical conditions.

1.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning site clearing operations. Contact locator service at 811 or (208) 342-1585.

D. Do not commence site clearing operations until temporary erosion and sedimentation measures are in place.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist. Refer to Geotechnical Evaluation for Soft Subgrade Construction Approach Recommendations.

F. Dust Control: Per Agency Having Jurisdiction.

1.6 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earthmoving"

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner’s Representative.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of Agencies Having Jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

E. Coordinate with SWPPP documents.

3.3 EXISTING UTILITIES

A. Contractor shall coordinate with Construction Manager to arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

C. Interrupting 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 Construction Manager not less than two (3) days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Construction Manager's written permission.

D. Excavate for and remove underground utilities indicated to be removed. Backfill & compact excavated utility trenches per specification section 312000.

3.4 CLEARING AND GRUBBING

A. Comply with Geotechnical Investigation.

B. Remove trees, shrubs, and other vegetation to permit installation of new construction.

C. Remove obstructions, pipes, ditches, etc. to permit installation of new construction.

D. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 6-Inches and compact each layer to a density equal to adjacent original ground.

2. All fill material placed must be compacted and tested. Coordinate with Construction Manager for testing.

3.5 TOPSOIL STRIPPING

A. Comply with Geotechnical Investigation.

B. Contractor shall remove all organic or disturbed soils beneath proposed pavements, flatwork, floor slabs, structural fills and building foundations.

C. All organic or disturbed soils shall be removed to depths of 18-inches minimum and stockpiled for later use in landscape areas or removed from site. Stripping depths shall be adjusted in the field to ensure that the entire root zone, disturbed zone or topsoil are removed prior to placement and compaction of structural fill materials.

D. Exact removal depths should be determined during grading operations by the Geotechnical Engineer and should be based upon subgrade soil type, composition, and firmness or soil stability.

E. Stripped topsoil may be stockpiled and used in future landscape areas only. Topsoil shall not be used as structural fill.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut adjacent to line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.

2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

C. If underground storage tanks, underground utilities, wells, or septic systems are discovered during construction activities, they must be decommissioned then removed or abandoned in accordance with governing Federal, State, and local agencies. Excavations developed as a result of such removal must be backfilled with structural fill materials. See section 31 20 00.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavation and backfilling for slabs-on-grade, walks, pavements and landscape areas.
2. Excavation and backfilling for building floor slabs, building foundations and structures.
3. Excavation and backfilling for storm drainage systems.
4. Excavation and backfilling trenches for utilities and pits for buried utility structures.
5. Excavation and backfilling geotechnical test pits.
6. Excavation and backfilling trenches where existing utilities are removed or modified.
7. Temporary erosion and sedimentation control measures.

B. Related Sections:

1. Division 01 Sections.
2. Division 03 Section "Cast-in-Place Concrete" for vapor retarder beneath the slab-on-grade.
3. Division 23, 26 and 27 Sections for installing underground mechanical, electrical and telecommunications utilities and buried mechanical and electrical structures.
4. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping topsoil, and removal of above- and below-grade improvements and utilities.
5. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.
6. Division 33 Sections for underground site utilities.
7. Idaho Standards for Public Works Construction, Current Edition.
8. Geotechnical Investigation and Addenda as prepared by Atlas Technical Consultants, LLC, File Number: T211194g.
9. SWPPP Documents.

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe. Initial backfill shall be Bedding Course.
2. Final Backfill: Backfill placed over initial backfill to fill a trench. Final Backfill shall be Bedding Course or Granular Structural Fill.

B. Base Course (Crushed Aggregate Base): Aggregate layer placed between the base course and hot-mix asphalt paving or concrete flatwork or cast in place concrete.

C. Subbase Course (Structural Fill): Aggregate layer placed between the subgrade and Base Course.

D. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

E. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

F. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

H. Fill: Soil materials used to raise existing grades.

I. Satisfactory Soil: Soil material in compliance with the Geotechnical Investigation.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, base course or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles and warning tapes.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 1557 (for rigid structures) or ASTM D 698 (for flexible pavements).
3. Sieve analysis for all structural fill materials.
4. Sieve analysis for topsoil.
5. Topsoil quality analysis.

C. Operations & Maintenance Data: Submit Materials Testing reports for compaction testing of all subgrades and fill materials.

1.4 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at Project site.

B. All gravel, base course, subbase, and other imported fill materials other than landscape fill and topsoil shall only be stockpiled in proposed impervious areas. No gravel or rock materials shall be stockpiled or temporarily placed in proposed landscape areas in order to prevent landscape areas from being contaminated with rock materials. If landscape areas become contaminated, the contractor shall restore them to specified requirements at no cost to the Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk materials with appropriate certificates.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earthwork operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations. Contact locator service at 811 or 208-342-1585.

C. Do not commence earthwork operations until temporary erosion- and sedimentation-control measures are in place.

D. Soft Subgrade Conditions: This site contains shallow fine-grained soils that are relatively high in moisture content and prone to pumping and rutting from rubber-tired construction equipment. Earth Moving methods which limit destabilizing areas of the site during earth moving activities shall be employed.

E. Construction operations during dry, warm weather conditions will help to limit development of unstable subgrade conditions. Construction during wet weather may not be possible, depending on the amount of precipitation.

F. SWPPP: Coordinate with SWPPP documents.

G. Dust Control: Per Agency Having Jurisdiction.

1.7 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. Materials shall be in compliance with the Geotechnical Investigation.

B. Structural Fill: Soils classified as GW, GP, SW, and SP in accordance with the USCS (ASTM D2487) as identified by the geotechnical engineer. Use of silty soils (USCS designation of GM, SM, and ML) as structural fill may be acceptable. However, use of silty soils and lean

clay soils (GM,SM, CL, and ML) as structural fill below footings and building floor slabs is prohibited.

C. Subbase Course (Granular Structural Fill): 6-Inch minus select, clean, granular soil with no more than 50 percent oversize (greater than 3/4-Inch) material and no more than 12 percent fines (passing No. 200 sieve). Refer to the ISPWC Section 801 for material gradation and requirements.

D. Base Course (Crushed Aggregate Base):

1. 3/4" maximum size- complying with ISPWC Section 802 – 3/4-inch (Type I) for material gradation and requirements.
2. Crushed Aggregate Base as defined herein shall be used as Free Draining Granular Mat as indicated by the geotechnical engineering report.

E. Bedding Course (Utility Trench Bedding):

1. Type I bedding material Per ISPWC Section 305 – in compliance with the following material gradation:

Sieve Size	Percent Passing
1-inch	100
3/4-inch	80-100
3/8-inch	20-70
No. 4	5-20
No. 8	0-5
No. 200	0-3

F. Drain Rock:

1. Per ISPWC Section 801 – in compliance with the following material gradation:

Sieve Size	Percent Passing
3-inch	100
1-inch	25-60
3/8-inch	0-4
No. 200	0-2

2. Drain rock shall have a minimum of 35% Air Voids as determined by AASHTO T 19.

G. Filter Sand:

1. Per ISPWC Section 801 – in compliance with the following material gradation:

Sieve Size	Percent Passing
3/8-inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10
No. 200	0-4

H. Topsoil Material:

1. Topsoil shall be free of refuse, constituents toxic or otherwise deleterious to plant growth, woody vegetation, stumps or roots, brush, stones, and clay lumps. Sod and herbaceous growth such as grass need not be removed but shall be thoroughly broken

up and mixed with the soil.

2. Grading and Quality Requirements: Contractor shall screen topsoil to meet gradation below or import topsoil to meet gradation below at no additional cost to Owner.:

   a. Topsoil Material Gradation:

Sieve Size	Percent Passing
1-inch	100
3/8-inch	85-100
No. 8	50-80
No. 200	0-20

   b. Topsoil Quality:

Test	Test Method	Requirements
Sampling Aggregate	ASTM D 75	-
Sieve Analysis	ASTM C 136 & C 117	Table - 2.1 | H. | 2. | a.
General Texture	ASTM D 422-63	Sand: < 70% Silt: < 70% Clay: < 30%
Organic Content	AASHTO T 194	> 2%
Soluble Salts	ASTM D 5298-10	< 2
PH	ASTM E 70	6.5 to 7.5

3. Representative samples from proposed topsoil source shall be tested for all quality items noted in 2.1, H. above, by a recognized commercial or governmental agency and copies of the testing results shall be furnished to the landscape architect by the contractor. Coordinate with Submittals, Part 1 of this section.

I. Landscape Mulch & Landscape Boulders: Per Specification Section 32 93 00.

2.2 GEOTEXTILES

A. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
4. Tear Strength: 56 lbf; ASTM D 4533.
5. Puncture Strength: 56 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 70 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.5per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Woven Geotextile: Woven geotextile fabric, manufactured for subgrade stabilization and soil improvements complying with the following minimum properties, measured per test methods referenced:

1. CBR Puncture: 700 lb; ASTM D 6241.
2. Grab Tensile Strength: 200 lb; ASTM D 4632.

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.
6. Purple: Irrigation mainline systems.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. Refer to Geotechnical Investigation for additional information.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

C. Protect and maintain erosion and sedimentation controls during earthwork operations.

D. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

E. The site shall be watered as required to moisture condition the native soils.

F. Notify Owner’s Representative of unexpected subgrade conditions and discontinue affected work in area until notified to resume work.

3.2 EXCAVATION: GENERAL

A. Refer to Geotechnical Investigation for additional information.

B. All excavation depths noted in this section shall be from existing ground surface. Total excavation depth from existing ground elevation may be greater than depth listed. Coordinate with drawings for more information.

C. Identify required lines, levels, contours and datum.

D. Protect above and below grade utilities which are to remain.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

F. Following excavation to subgrade and prior to fill placement; subgrade surfaces shall be proof rolled in the presence of the geotechnical engineer. Correct Soft Subgrade Soil areas as identified and directed by the Geotechnical Engineer. Proof rolling of subgrade soils shall be accomplished using a heavy rubber-tired, fully loaded, tandem-axle dump truck or equivalent.

G. Inspection & compaction testing shall be completed per the Division 01 Specifications.

3.3 EXCAVATION AND BACKFILL AT GEOTECHNICAL TEST PITS & DEMOLISHED UTILITIES

A. Refer to Geotechnical Investigation for location and depth of test pits.

B. Excavate full depth of test pit or utility until undisturbed, native subgrade is encountered.

C. Place Granular Structural Fill to total depth necessary to bring test pit to proposed subgrade elevation. Place in maximum 12-inch loose lifts and compact to a minimum of 95% per ASTM D1557.

D. Surface of compacted structural fill shall be smooth, even surface. Remove ridges and fill depressions.

E. Coordinate placement and grade with Excavation for Structures, Building Slabs, Building Foundations, Concrete Flatwork & Pavements, this section.

F. Inspection & compaction testing shall be completed per the Division 01 Specifications.

3.4 EXCAVATION FOR STRUCTURES, BUILDING SLABS AND BUILDING FOUNDATIONS

A. Excavate to indicated lines, cross sections, elevations, and subgrades.

B. Existing topsoil material must be completely removed from below building slabs and building foundation elements. Coordinate with specification section 31 10 00.

C. The exposed subgrade shall be proof-rolled and approved by the Geotechnical Engineer.

D. Repair soft subgrade soil areas as identified and directed by the Geotechnical Engineer.

3.5 EXCAVATION FOR CONCRETE FLATWORK AND PAVEMENTS

A. Excavate to indicated lines, cross sections, elevations and subgrades.

B. The exposed subgrade shall be proof-rolled and approved by the Geotechnical Engineer.

C. Repair soft subgrade soil areas as identified and directed by the Geotechnical Engineer.

D. Excavate to adequate depth for placement of Structural Fill, Subbase Course and/or Base Course Soil Materials.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Comply with the requirements of the ISPWC and the Local Agency Having Jurisdiction Standard Specifications.

B. Excavate trenches to indicated gradients, lines, depths and elevations. Utility cover shall be per Division 33 and the Drawings.

C. Excavate trenches to a minimum width of 24 inches plus pipe or conduit outside diameter. Provide uniform clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

D. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

3.7 EXCAVATION FOR LANDSCAPE AREAS

A. Excavate to indicated lines, cross sections, elevations and subgrades.

B. The exposed subgrade shall be visually inspected to confirm it is firm and unyielding.

C. Subgrade upper 6-inches shall be compacted to 92% of ASTM D698.

D. Repair soft subgrade soil areas as identified and directed by the Geotechnical Engineer.

E. Excavate to adequate depth for placement of Topsoil at all landscape areas, coordinate with drawings and specification section 32 93 00.

3.8 SUBGRADE INSPECTION

A. Notify Owner’s Representative when excavations have reached required subgrade elevations.

B. Prior to placement of subbase course and base course material at building and paved areas, the exposed subsoil surface should be proof-rolled under the observation of the Geotechnical Engineer.

C. Cut out soft or otherwise unsuitable areas of subgrade not capable of supporting structural loads. Backfill with Granular Structural Fill and compact to density equal to or greater than requirements for subsequent backfill material. Prior to placing Granular Structural Fill, the Geotechnical Engineer shall evaluate the over-excavated subgrade to determine if a Geotextile should be placed on the over-excavated subgrade.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owner’s Representative.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Protect as necessary to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations.

2. Coordinate stockpile requirements with the requirements of the Agency Having Jurisdiction and acceptable BMP’s.

B. Prepare and amend topsoil per specification section 32 93 00.

3.10 BACKFILL - GENERAL

A. Upon approved preparation and compaction of subgrade, placement of Structural Fill, Subbase Course and Base Course Fill shall proceed.

B. Place Backfill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Surface of Backfill shall be smooth, even surface. Remove ridges and fill depressions as required to meet finish grades.

D. Coordinate placement with Specification Section 033000 and Civil, Architectural and Structural Drawings.

3.11 STRUCTURAL FILL - GENERAL

A. Soils for use as Structural Fill shall be as defined the by Geotechnical Investigation and this section.

B. Place Structural Fill as required to achieve correct subgrade elevation for placement of Subbase Course and Base Course fill.

C. Structural Fill materials should be placed in layers not to exceed 6-inches in loose thickness.

D. Structural Fill material should be moisture-conditioned to achieve optimum moisture content prior to compaction.

E. Each layer of fill should be compacted to the following density:

1. Below Rigid Pavements: A minimum of 95% of maximum dry density, as determined by ASTM D 1557.
2. Below Flexible Pavements: A minimum of 92% of ASTM D1557 or 95% of ASTM D698.

3.12 GRANULAR STRUCTURAL FILL - GENERAL

A. Soils for use as Granular Structural Fill shall be as defined by this section.

B. Fill materials should be placed in layers not to exceed 12-inches in loose thickness.

C. Granular Structural Fill material should be moisture-conditioned to achieve optimum moisture content prior to compaction.

D. Each layer of fill should be compacted to the following density:

1. Below Structures and Rigid Pavements: A minimum of 95% of maximum dry density, as determined by ASTM D 1557.
2. Below Flexible Pavements: A minimum of 92% of ASTM D1557 or 95% of ASTM D698.

3.13 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill utility trenches using Bedding Course or Granular Structural Fill, compacted as specified below. Sufficient backfill should be placed over the utility before compacting with

heavy equipment to prevent damage.

D. Subbase Course Fill should be placed and compacted to density equal to or greater than requirements for subsequent backfill material.

E. Place Subbase Course Fill at the following maximum loose depths prior to compaction:

1. Bedding Course: 6-Inch lifts prior to compaction
2. Granular Structural Fill: 12-Inch lifts prior to compaction.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12-inches below finished grade, except 6-inches below subgrade under pavements and slabs.

3.14 SUBBASE COURSE FILL

A. Upon approved preparation and observed proof-rolling of subgrade, placement of Subbase Course Fill shall proceed.

B. Place Granular Structural Fill as required to achieve correct subgrade elevation for placement of Base Course fill and indicated surface improvements. Place Subbase Course fill in maximum 12-inch lose lifts and compact as noted below.

C. Surface of Subbase Course Fill shall be smooth, even surface. Remove ridges and fill depressions as required to meet finish grades.

D. Coordinate with Specification Section 03 30 00 and Architectural and Structural Drawings for placement for Building Foundations and Building Floor Slab.

E. Each layer of Subbase Course fill should be compacted to the following density:

1. Below Building Foundations, Building Floor Slab, Structures and Rigid Pavements: A minimum of 95% of maximum dry density, as determined by ASTM D 1557.
2. Below Flexible Pavements: A minimum of 92% of ASTM D1557 or 95% of ASTM D698.

3.15 BASE COURSE FILL

A. Upon approved placement and compaction of Structural Fill and Subbase Course Fill, placement of Base Course Fill shall proceed.

B. Place and compact Base Course material in layers to required elevations. Place in maximum 6-inch lose lifts.

C. Place Base Course materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

D. Surface of Base Course shall be smooth, even surface. Remove ridges and fill depressions as required to meet finish grades.

E. Base Course Fill at Structures, Building Slabs and Building Foundations:

1. Building Floor Slabs: Compacted depth as shown on the Drawings
2. Structures: Compacted depth as shown on the Drawings.

3. Building Foundations: Not required.
4. Coordinate with Specification Section 03 30 00 and Architectural and Structural Drawings.

F. Base Course at Paving, Curbs and Walks:
1. Asphalt Paving: Compacted depth as indicated on the drawings.
2. Concrete Flatwork, Curbs & Walks: Compacted depth as indicated on the drawings.

G. Place Base Course in maximum 6-inch thick loose lifts to bottom of structure, building slab, pavement, curb or walk. Base Course shall be moisture conditioned to within 2 percent of the optimum moisture.

H. Each layer of Base Course fill should be compacted to the following density:
1. Below Structures and Rigid Pavements: A minimum of 95% of maximum dry density, as determined by ASTM D 1557.
2. Below Flexible Pavements: A minimum of 95% of the maximum dry density as determined by ASTM D 698.

3.16 LANDSCAPE FILL

A. Coordinate placement of topsoil with Specification Section 32 93 00 and drawings.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus ½-inch.
3. Pavements: Plus or minus ½-inch.

C. Site drainage should be directed away from structural areas, to avoid ponding of waters during storm events.

D. Grading inside Building Lines: Finish subgrade to a tolerance of 1/4 inch when tested with a 10-foot straightedge.

3.18 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of Division 1.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Owner's Representative.

E. Testing agency will perform compaction testing at the following locations and frequencies:

1. Pavement, Walks and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 5,000 SF (Building Slab) and every 10,000 SF (paved areas) but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer (maximum 8" lifts), at least one test for every 100 feet or less of trench length, but no fewer than two tests.
4. Landscape Fill: at each compacted fill and backfill layer, at least one test for every 20,000 SF but in no case fewer than two tests.
5. Geotechnical Test Pits & demolished utilities: one test at each compacted fill layer at each test pit or demolished seepage bed.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; re-compact and retest until specified compaction is obtained.

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Owner's Representative; reshape and re-compact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-mix asphalt patching
2. Hot-mix asphalt paving
3. Pavement-marking paint

B. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Division 07 Section "Joint Sealants" for joint sealants and fillers at paving terminations.
3. The Asphalt Institute - Manual MS-4 - The Asphalt Handbook.
4. The Asphalt Institute - Manual MS-13 - Asphalt Surface Treatments for Asphalt Penetration Macadam.
5. Idaho Standards for Public Works Construction, Current Edition.
6. AHJ Standards and Specifications.
7. Geotechnical Investigation and Addenda as prepared by Atlas Technical Consultants, LLC, File Number: T211194g.

1.2 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. AHJ: Authority Having Jurisdiction

1.3 SUBMITTALS

A. Submit under provisions of Division 01 Specifications.

B. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

C. Submit design mix under provisions of Division 01.

D. Sieve analysis for all course and fine aggregate materials.

E. Submit pavement marking product data under provisions of Division 01.

F. Material Certificates: For each paving and striping material, from manufacturer.

G. Material Test Reports: For each paving material.

H. Operations & Maintenance Data: Submit Materials Testing reports for compaction testing of all asphalt paving.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with the Current Edition of the Idaho Standards for Public Works Construction.

B. Mixing Plant: Conform to the Current Edition of the Idaho Standards for Public Works Construction and comply with ASTM D 3515.

C. Obtain materials from same source throughout duration of project.

1.5 HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 deg F.

2. Asphalt Single Course: Minimum surface temperature of 40 deg F and rising at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

C. As-Built Topographic Survey: Coordinate with Part 3 of this section.

1.7 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphaltic Concrete: Asphalt mix design shall meet the requirements of the ISPWC, Section 810 for Class III Plant Mix.

B. Base Course (crushed aggregate base): Refer to Specification Section 31 20 00.

C. Subbase Course (granular structural fill): Refer to Specification Section 31 20 00.

D. Structural Fill: Refer to Specification Section 31 20 00.

E. Asphalt-Aggregate Mixtures: 1/2-inch mix design according to ISPWC Section 803.

F. Comply with requirements of AHJ for all asphalt work in the Right of Way.

2.2 ASPHALT MATERIALS

A. Asphalt Cement and Bituminous Materials per ISPWC Section 805.

B. The Contractor shall provide the Engineer with a Mix Design for approval prior to placement of Bituminous Paving Materials.

C. Plantmix Bituminous Pavement shall be Type 3, unless otherwise specified or approved.

D. Asphalt Tack Coat: per ISPWC Section 806.

E. Asphalt Prime Coat: per ISPWC Section 807.

F. Water: Potable.

G. Comply with requirements of AHJ for all asphalt work in the Right of Way.

2.3 AUXILIARY MATERIALS

A. Sand: AASHTO M 29, Grade Nos. 2 or 3.

B. Joint Sealant: AASHTO M 324, Type II of III.

C. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248; colors complying with FS TT-P-1952.

1. Color: Per the plans.

D. Glass Beads: AASHTO M 247, Type 1. Roadway pavement markings only.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that Base Course below proposed pavement areas is dry and in suitable condition to begin paving.

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

C. Verify that utilities, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.10 gal/sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

D. Comply with requirements of AHJ for all asphalt work in the Right of Way.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.

2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared crushed surfacing below proposed pavement areas is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.10 gal/sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Surface Course: The surface course lift shall be placed as near project substantial completion as possible.

1. If Base course pavement exists, it shall be cleaned to remove all debris and dust.

2. Visually inspect base course pavement for mechanical or chemical damage. All areas with chemical damage, i.e. dripped fuels, or mechanical damage shall be identified and marked with paint for review by the Architect. All areas determined to require patching shall be patched per 3.2 of this Section prior to placement of surface course.

3. Apply tack coat to base course prior to placement of surface course at a rate of 0.15 gal/sq. yd.

3.5 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Light Duty Asphalt: Place hot-mix asphalt in single lift to 2.5-Inch compacted thickness.

2. Heavy Duty Asphalt: Place hot-mix asphalt in single lift to 3.0-Inch compacted thickness.
3. Spread mix at minimum temperature as required by binder temperature/viscosity curve.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat to cold joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time.
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
1. Compaction: 91% - 96% with a minimum average of 92%. Joint density should be at least 90 percent of Rice density.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course Asphalt Lift: Plus or minus 1/4-inch.
2. Surface Course Asphalt Lift: Plus 1/4-inch, no minus.

B. Pavement Surface Smoothness: Comply with ISPWC Section 810. Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course Asphalt Lift: 1/4 inch.
2. Surface Course Asphalt Lift: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Comply with the AHJ standards for all markings in the Right of Way.

C. Apply per ISPWC Section 1104.

D. Protect newly applied pavement-marking paint until it has fully cured.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field inspection and testing will be performed under provisions of Division 1.

C. Take samples and perform tests in accordance with The Asphalt Institute.

D. Frequency of Tests: Density Tests: 1 per 2000 sq. ft.

E. All paved surfaces shall be flooded with water in the presence of the Engineer to verify that all surfaces completely drain and no low depressed areas exist. A minimum of 48 hours notice shall be given.

F. Excessive rock pockets and/or cold joints (surface irregularities) are not acceptable and shall be corrected in a manner acceptable to the Engineer at no cost to the Owner.

G. Replace and compact hot-mix asphalt where core tests were taken.

H. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

I. Comply with requirements of AHJ for all asphalt work in the Right of Way.

3.11 PROTECTION

A. Immediately after placement, protect pavement from mechanical and chemical damage until date of Substantial Completion.

3.12 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow milled materials to accumulate on-site.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Site flatwork, sidewalks, curbs, gutters and mow strips.
2. Bases for light poles, furnishings, walls and signs.
3. Reinforcing.
4. Joint Filler and Joint Sealant.
5. Pavement-marking paint.
6. Miscellaneous items shown.

1.2 RELATED SECTIONS

A. Division 31 Earth Moving.

B. Idaho Standards for Public Works Construction, Current Edition.

C. AHJ Standard Specifications.

D. Geotechnical Investigation and Addenda as prepared by Atlas Technical Consultants, LLC, File Number: T211194g.

1.3 SUBMITTALS

A. Submit under provisions of Division 01 Specifications.

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

C. Sieve analysis for all course and fine aggregate materials.

D. Shop Drawings:

1. Provide contraction joint, isolation joint and pour sequence layout plan for review and approval.
2. Indicate reinforcing steel sizes, spacing, locations and quantities for reinforcing steel, bending and cutting schedules, splicing, and supporting and spacing devices.

E. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Concrete testing data shall have been completed within 12 months of the submittal date.

F. Qualification Data: Ready-mix concrete manufacturer and testing agency.

G. Operations & Maintenance Data: Submit Materials Testing reports for sample and strength testing of all site concrete work.

1.4 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing

ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301 and ACI 316 unless otherwise indicated.

1.5 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, flat sheet.

C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

D. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

E. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

F. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

G. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated

wire bar supports.

I. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

J. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

A. Cementatious Material: Provide in accordance with ISPWC Division 700. Portland Cement Type I or II.

B. Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source. Refer to ISPWC Section 703 for aggregate requirements.

1. Maximum Coarse-Aggregate Size 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Use 1/2 inch maximum sized aggregate and high range water reducer in concrete at all round columns and exposed concrete wall to reduce bug holes and surface imperfections. Sack finishing will not be acceptable to cure surface problems.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

F. Fiber Reinforcement Admixture: Fibermesh® 650 or approved equal.

1. Reference plan details for locations required.
2. Install per manufactures recommendations.

2.4 CURING MATERIALS

A. Curing Compound: ASTM C 309, Type 1, Class A, water based.

B. Pre-Approved Product: W.R. Meadows 1100-Clear.

2.5 JOINT MATERIALS – STANDARD CONCRETE FLATWORK

A. Joint Fillers:

1. 1/2 thick Fiber Joint Filler as manufactured by W.R. Meadows, or approved equal.

Provide resilient and non-extruding type pre-molded bituminous-impregnated fiberboard complying with ASTM D1751.

2. Use with Snap-Cap as manufactured by W.R. Meadows, or approved equal where joint is to be sealed. Coordinate with Drawings for location.

B. Joint Sealant: provide at locations shown on drawings.

1. Tremco THC-901 – High Performance Multi-Component Polyurethane Sealant, or approved equal. Sealant shall meet or exceed the following specifications:

a. U.S. Federal Specification TT-S-00227E, Class A, Type I

b. ASTM C 920, Type M, Grade P, Class 25, Use T, M, & O

2. Tremco Universal Color Pak or pre-tinted in limestone. Color to match surrounding concrete flatwork.

2.6 JOINT MATERIALS – HEAVY DUTY CONCRETE FLATWORK

A. Joint Fillers and Sealants:

1. As shown on drawings and per ITD Standard Drawings and Specifications for Highway Construction.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi with modulus of rupture greater than 650 psi.

2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.

3. Slump Limit: 3 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete as required for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements as follows:

1. Fly Ash or Pozzolan: 25 percent.

2. Ground Granulated Blast-Furnace Slag: 50 percent.

3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

F. Fiber Reinforcement Admixture:

1. Reference plan details for locations required.

2. Install per manufactures recommendations.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2.9 AUXILIRY MATERIALS

A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248; colors complying with FS TT-P-1952.

1. Color: Per the plans.

B. Glass Beads: AASHTO M 247, Type 1. Roadway pavement markings only.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed base course surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared base course surface below concrete flatwork, curb and paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll base course. Limit vehicle speed to 3 mph.

2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Correct soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving."

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

3.2 PREPARATION

A. Remove loose material from compacted base course surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required

lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Refer to drawings for location of reinforcement at all utility structures.

C. Coordinate with drawings for reinforcement at building doorways.

D. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

E. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

F. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

G. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

H. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

3.5 JOINTS

A. General:

1. Refer to drawings and details for additional information and requirements.
2. Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
3. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Construction joints within heavy duty concrete flatwork shall be constructed as isolation joints as detailed on plans. Contractor shall provide joint layout and pour sequence layout plan for review and approval.
2. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
3. Provide tie bars at sides of paving strips where indicated.
4. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

5. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

6. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, columns, other fixed objects, new concrete flatwork to old concrete flatwork, and where indicated.

1. Isolation joints within heavy duty concrete flatwork shall be constructed as detailed on plans. Contractor shall provide joint layout and pour sequence layout plan for review and approval.

2. Extend joint fillers full width and depth of joint. No plug or sliver of concrete should extend over, under, through, around, or between sections of the filler board.

3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated. Utilize filler board cap at all sealed joints.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

7. Place joint sealant per Manufacturer’s written specifications.

a. Surfaces must be sound, clean and dry. Apply to surface when temperatures are 40 deg. F or above.

b. Mix in accordance with written instructions on product packaging.

c. Ensure joint filler is installed properly.

d. Excess sealant and smears adjacent to the joint shall be carefully removed in accordance with written instructions.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-third of the concrete thickness, as follows:

1. Contraction joints within heavy duty concrete flatwork shall receive backer rod and sealant as detailed on plans. Contractor shall provide joint layout and pour sequence layout plan for review and approval.

2. Grooved Joints: Saw joints at locations shown.

3. Contraction Joints shall be constructed at the optimum time to prevent raveling (too early) and cracking (too late). Excessive raveling and chipping of joint edge will be cause for slab replacement.

4. Jointed panels should be as close to square as possible.

5. Contraction joints should be straight and continuous. Align joints of adjacent panels.

6. Align joints in attached curbs with joints in pavement.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/2-inch radius. Repeat tooling of edges after applying surface

finishes. Eliminate edging-tool marks on concrete surfaces.

F. Coordinate with Civil Drawings and Structural Drawings for Doweled Joints at building doorways.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Place reinforcing bars at locations shown on drawings.

E. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

F. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

I. Screed paving surface with a straightedge and strike off.

J. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

K. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

L. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

M. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not

less than 50 deg F and not more than 80 deg F at point of placement.

2. Do not use frozen materials or materials containing ice or snow.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.

b. Continuous water-fog spray.

c. Absorptive cover, water saturated and kept continuously wet. Cover concrete

surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. ACI 117 establishes few paving tolerances; those in subparagraphs below are based on ACI 330.1. Revise to suit Project.
2. Elevation: 1/4 inch flatwork
3. Thickness: Plus 3/8 inch, minus 1/4 inch.
4. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
5. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
6. Lateral Alignment and Spacing of Dowels: 1 inch.
7. Vertical Alignment of Dowels: 1/4 inch.
8. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
9. Joint Spacing: 3 inches.
10. Contraction Joint Depth: Plus 1/4 inch, no minus.
11. Joint Width: Plus 1/8 inch, no minus.

3.10 PAVEMENT MARKING - GENERAL

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Comply with the AHJ standards for all markings in the Right of Way.

C. Apply per ISPWC Section 1104.

D. Protect newly applied pavement-marking paint until it has fully cured.

3.11 PAVEMENT MARKING - DO NOT ENTER

A. Border:

1. 4 inch wide red stripe. 5 foot tall border with width matching the extents of the approach. Paint shall not impede pedestrian access across approach.

B. Lettering:

1. 3 feet tall red letters at 6 inch width.

C. Angled Hatching:

1. 4 inch wide red stripe at 2 foot on center spacing. Stripes should be at 45 degree angle to border and not impede lettering.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.13 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections. Pressure washing or other method shall be used to remove stains and tire markings if necessary.

E. All concrete paving shall be broom clean at date of Substantial Completion.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Decorative aluminum fences.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fencing and gates.

PART 2 - PRODUCTS

2.1 DECORATIVE ALUMINUM FENCES

A. Posts: Square extruded tubes. Size and gauge as indicated on Civil Drawings

B. Post Caps: Aluminum castings that cover entire top of posts.

C. Rails: Size and gauge as indicated on Civil Drawings

D. Pickets: Extruded-aluminum tubes, Size and gauge as indicated on Civil Drawings

1. Picket Spacing: Four inches clear, maximum.

E. Fasteners: Manufacturer's standard corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

F. Fabrication: Assemble fences into sections by fastening pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.
2. Drill clips for fasteners before finishing.

G. Finish: Baked enamel or powder coating.

2.2 ALUMINUM

A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.

B. Extrusions: ASTM B221, Alloy 6063-T5.

C. Tubing: ASTM B429/B429M, Alloy 6063-T6.

D. Plate and Sheet: ASTM B209, Alloy 6061-T6.

E. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.

F. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.3 ALUMINUM FINISHES

A. Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

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

3.2 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Install plumb, true, and level.

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil, and as indicted on drawings.

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bicycle racks.
2. Flagpoles.
3. Basketball Standard

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. For flagpoles include wiring diagrams and foundation requirements.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 BICYCLE RACKS

A. Single loop, nominal 2-inch diameter grade 304 stainless steel, surface mounted. Manufacturer: Dero. Model: Hoop Rack nominal 36 inches high x 24 inches wide.

2.2 GROUND SET FLAGPOLES

A. Performance Requirements

1. Seismic Performance: Flagpole assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
2. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand design loads indicated within limits and under conditions indicated.
3. Wind Loads: Determine according to NAAMM FP 1001. Basic wind speed for Project location as indicated on structural drawings.
4. Base flagpole design on polyester, nylon or cotton flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

B. Aluminum Flagpoles

1. Aluminum Flagpoles: Tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B241/B241M, Alloy 6063, with a minimum wall thickness of 3/16 inch.
2. Usually retain one option in "Exposed Height" Paragraph below if only one flagpole height is required. For complex flagpoles, such as nautical types, indicate flagpoles on Drawings and delete paragraph.

3. Exposed Height: 25 feet.
4. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
5. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
6. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

C. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch wall thickness with 3/16-inch steel bottom plate and support plate; 3/4-inch-diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.

1. Flashing Collar: Same material and finish as flagpole.

D. Lighting

1. Top mounted dual-light 300K LED downlights to illuminate flag.
2. 0.063-inch spun aluminum, finished to match flagpole.

E. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous 5/16-inch-diameter, braided polypropylene halyard and 9-inch cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.

1. Halyards and Cleats: One at each flagpole.
2. Halyard Flag Snaps: Chromium-plated bronze, Stainless-steel, or Nylon swivel snap hooks. Furnish two per halyard.

F. Miscellaneous Materials

1. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

G. Aluminum Finishes

1. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.

H. Flag

1. American flag, 2-ply 100% spun polyester with individually embroidered stars, sewn stripes and spurred brass grommets. Size: Five feet x eight feet.

2.3 BASKETBALL STANDARD

A. Single Sided - Bison: Fixed Height Ultimate Series – Model #BA871-BK Single Sided with 60-inch offset, 42”x60” steel backboard and Model #BA39U Ultimate Goal. Goal height: 10-foot. QUANTITY – per drawing.

B. Net: Web Nylon Playground Basketball net, Gared Sports, www.garedsports.com, or equal. Attach to goal with ¼-inch threaded, 316 grade stainless steel screw link. Attach at all 12 mounting points.

C. In-ground mount with concrete footing per manufacturer’s written details and specifications at location shown on the drawings. Coordinate footing with asphalt paving.

D. Manufacturer’s Standard powder coat finish on pole: Color- Black.

E. Installation per manufacture’s written installation procedures and details.

F. Bison, Inc.: (800) 247.7668 or www.bisoninc.com.

PART 3 - EXECUTION

3.1 BICYCLE RACKS

A. Surface mount to concrete as indicated on drawings and per manufacturer’s instructions. Secure bolts with stainless steel acorn nuts.

3.2 FLAGPOLES

A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.

B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.

C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.

D. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.

E. Place concrete, as specified in Section 033000 "Cast-in-Place Concrete." Compact concrete in place by using vibrators. Moist-cure exposed concrete for no fewer than seven days or use nonstaining curing compound.

F. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

G. General: Install flagpoles where indicated and according to Shop Drawings and manufacturer's written instructions.

H. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of elastomeric joint sealant and cover with flashing collar.

END OF SECTION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes

1. Pipe and fittings, valves, sprinkler heads, dripper line, accessories, and connections to water source.

2. Control system.

B. System Description

1. Electric solenoid controlled automatic underground irrigation system.

C. Related Sections

1. Division 26 Sections for Electrical Power Materials and Installations.

2. Division 31 Sections for Earthmoving

3. Division 32 Sections for Turf and Grasses and Plants

1.3 DEFINITIONS

A. Pipe sizes used in this Section are nominal pipe size (NPS) in inches. Tube sizes are Standard size in inches.

B. Pressure Piping Main Line: Piping downstream from supply piping to and including control valves. Piping is under irrigation system pressure. Piping in this category includes backflow preventers.

C. Circuit Piping Lateral Lines: Piping downstream from control valves to irrigation system sprinklers. Piping is under pressure (less than pressure piping) during flow.

D. Control Valve: Automatic (electrically operated) valve for control water flow to irrigation system zone.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Location of Sprinklers and Devices: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards.

B. Minimum Water Coverage: Not less than:

1. Planting Areas: 100 percent.

C. All flow velocities, within the entire irrigation system, shall not exceed 5 feet per second.

1.5 SUBMITTALS

A. Product data including pressure rating, rated capacity, settings, and electrical data of selected models for the following:
   1. Backflow preventers, including test equipment
      a. Valves, including general-duty, underground, automatic control, and quick-coupler types, isolation, valve boxes, and valve ID tags.
      b. Drip tubing
      c. Irrigation Controller, including controller wiring diagrams
      d. Wiring
      e. Irrigation system record drawings
      f. Pipe, Fittings, etc.

B. Wiring diagrams for electrical controllers, valves, and devices. Valve numbers shall reflect station numbers within the controller and shall be noted on the as builts.

C. Maintenance data for inclusion in "Operating and Maintenance Manual" specified in Division 1 Section "Contract Closeout" for the following:
   1. Seasonal activities of start-up, shut-down and winterization, including blow-out operation of sprinkler system with compressed air
      a. Backflow preventers, including instructions for testing
      b. Automatic control valves
      c. Controllers
      d. Drip tubing
      e. Irrigation system record drawings

1.6 QUALITY ASSURANCE

A. Comply with requirements of utility supplying water for prevention of backflow and backsiphonage. Comply with appropriated water rights.

B. Installer Qualifications: Engage an experienced Installer with a minimum of five years experience and who has completed irrigation systems similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.

C. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.

D. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100.
      a. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

E. Product Options: Irrigation system piping, specialties, and accessories are based on specific types, manufacturers, and models indicated. Components with equal performance

characteristics produced by other manufacturers may be considered, provided deviations in dimensions, operation, and other characteristics do not change design concept or intended performance as judged by the Architect. The burden of proof of product equality is on the Contractor. All substitutions must be approved by the Architect in writing prior to installation per section 1.10.

1.7 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Verify that irrigation system piping may be installed in compliance with original design and referenced standards. Verify that domestic supply performs as specified.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate irrigation systems work with landscape work specified and in the drawings.

1.9 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and label clearly describing contents.

1. Utilized drip fittings, drip drain valves – (12) each type and size

2. Remote Control Valve – (2) each type and size

3. Valve box w/ lid – (1) each type and size

4. Valve key – (1) each type

1.10 IRRIGATION RECORD DRAWINGS

A. Record accurately, on one set of black and white prints of the site plan, all installed work including both pressure and non-pressure lines and pipe sizes.

B. Upon completion of each increment of work, transfer all such information and dimensions to the print. The dimensions shall be recorded in a legible and workmanlike manner. Maintain as-built drawings on site at all times. Make all notes on drawing in pencil (no ball point pen). When the work has been completed, transfer all information from the field record print to a set of reproducible drawings.

C. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavements, etc.). Locations shown on as-built drawings shall be kept day to day as the project is being installed. All dimension text noted on drawings shall be 1/8 inch in size (minimum).

D. Show locations and depths of the following items:

1. Point of connection

2. Routing of drip irrigation lines

3. Gate valves

4. Control valves

5. Routing of control wires and rain sensor wires

6. Splice boxes

7. Other related equipment noted on plan and legend

1.11 SUBSTITUTIONS

A. Coordinate substitutions per Division 1.

B. Substitutions to the specified equipment will be permitted with the express written approval of the Architect. Substitutions will be approved only when the substituted item is equivalent or better in quality and performance than the item originally specified. The final determination for "equivalents" rests with the Architect. Their decision shall be final and binding.

1.12 WARRANTY

A. Warranty system against defects of installation and material for a period of 1 year after final completion of the irrigation system. Guarantee shall also cover repair or damage to any part of the premises resulting from leaks or other defects in material, equipment, and workmanship to the satisfaction of the Architect. Repairs, if required, shall be done promptly upon notification by the Owner, and, at no cost to the Owner.

B. As part of the warranty, the Contractor shall be responsible for deactivating and winterizing the system prior to the onset of the freezing season and for reactivating the system at the onset of the spring growing season; each event must be accomplished once during the warranty period. In the event the system is completed in a season when it will not be in use, the Contractor shall winterize the system upon completion of testing (and approval by the Architect) and reactivate the system in the spring. The Contractor shall SUBMIT a letter to the Architect certifying that the system was winterized and drained and indicate the date such action was accomplished. The Contractor shall be responsible for any damage resulting from failure to comply. Contractor shall instruct and demonstrate winterization and startup techniques for Owner.

PART 2 - PRODUCTS

2.1 SUMMARY

A. All materials used throughout the system shall be new, unused, and in perfect condition. Refer to the irrigation materials legend, notes, detail drawings and these specifications for specific equipment to be used. Equipment or materials installed or furnished without prior approval of the Architect may be rejected and the Contractor required to remove such materials from the site at his own expense.

B. Substitutions: Under provisions of Division 1 and 32 84 00, paragraph 1.10.

2.2 PLASTIC PIPE AND ACCESSORIES

A. Pipe

1. Pipe walls shall be uniform, smooth, glossy, and free of interior or exterior extrusion

marks; pre-belled or straight to receive solvent-weld couplings; 20 foot standard lengths.

2. Pipe shall be marked with manufacturer's name, class of pipe, NSF seal, and date/shift of manufacturing run.

3. PVC Pipe: ASTM D1785, D2241

B. Fittings: PVC - ASTM D2464, D2466.

C. Irrigation System Plastic Pipe

1. Mainline: size and type per plans. Use SDR26 solvent weld fittings or ductile iron fittings per size of mainline. Refer to plans.

2. Laterals: size and type per plans. Install with SDR26 solvent weld fittings.

3. Sleeving: ASTM D 1785, Class 200, polyvinyl chloride (PVC) plastic pipe; ASTM D 2466, Schedule 40, PVC plastic, socket-type fittings; and solvent-cemented joints.

4. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube materials specified below are used.

D. Pipe and Tube Fittings

1. Refer to Part 3 Article "Piping Applications" for identification of systems where pipe and tube fitting materials specified below are used.

2. Polyvinyl Chloride (PVC) Plastic Pipe Fittings: ASTM D 2464, Schedule 80, threaded.

3. Polyvinyl Chloride (PVC) Plastic Pipe Fittings: ASTM D 2467, Schedule 40, socket-type.

4. “Leemco” Push-on joint Ductile Iron Epoxy Coated Fittings: for all pipes 3” and larger.

5. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion. These devices are a combination of copper alloy and ferrous metal; threaded- and solder-end types, matching piping system materials.

a. Dielectric Unions: Factory-fabricated, union assembly, designed for 250 psig (1725 kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B1.20.1.

b. Transition Fittings: Manufactured assembly or fitting, with pressure rating at least equal to that of system and with ends

2.3 JOINING MATERIALS

A. Solvent Cement: ASTM F 656 primer and ASTM D 2564 solvent cement in color other than orange.

2.4 VALVES

A. General: Valves are for general-duty and underground applications. Refer to "Valve Applications" Article for locations of various valve types specified in this Article. Refer to "Control Valves" Article for control valves and accessories.
1. Automatic Control Valves: Manufacturer, model and size as noted on the drawings.
2. Isolation Valves, Manufacturer, model, and size as noted on the drawings.
3. Quick Coupler Valve & Key: Manufacturer, model and size as noted on the drawings.

2.5 CONTROL VALVES

A. Description: Manufacturer's standard control valves for circuits, of type and size indicated on Drawing, and as follows:
1. Angle Valves: As noted on the Drawings.
2. Automatic Control Valves: Diaphragm-type, normally closed, with manual flow adjustment, and operated by 24-volt-a.c. solenoid.
3. Drain Valve: As noted on the Drawings.
4. Isolation Valves: As noted on Drawings.

B. Control Valve Boxes and Cover: Thermo-plastic valve boxes with lockable, snap-top lids. Size as required for application or as noted on drawings, maximum one (1) valve per box. All boxes shall have green lids labeled “Irrigation” in English and Spanish.

1. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3 inches (75 mm) maximum to 3/4 inch (19 mm) minimum. Cover gravel with layer of filter fabric.

C. Service Boxes for Key-Operated Control Valves: Size and type as shown on Drawings.

1. Include valve key, 48 inches (915 mm) long with tee handle and key end to fit valve.

D. Irrigation System Controls

1. Controller: As noted on the Drawings. All control wires that are above ground shall be installed in rigid steel conduit. Electrical wiring shall be installed according to local code. Provide surge protectors install controllers.
2. Controller Housing: Weatherproof, watertight, with lockable access door.
3. Valves: Electric Solenoid type and size of control valves as noted on the Drawings, including required fittings and accessories.
4. Wire: Per 2.7 Automatic Control System; G.
   a. Provide grounding per manufacturer’s specifications.

2.6 DRIP IRRIGATION

A. Description: Manufacturer’s standard drip irrigation designed to provide uniform coverage over the entire area shown on Drawings at available water pressure, as follows:

1. Distribution tubing: Manufacturer, model and size as noted on the drawings.
2. Filtration: Manufacturer, model and size as noted on the drawings. Each dripper zone shall include filtration between remote control valve and dripline.
3. Flushing Valve: Manufacturer, model and sizer as noted on the drawings. Flush valve shall be installed at all points furthest from point of connection.

2.7 AUTOMATIC CONTROL SYSTEM

A. Description: Low-voltage controller system, made for control of irrigation system automatic control valves. Controller operates on 120 volts a.c. building power system, provides 24 volts a.c. power to control valves, and includes stations for at least the number of control valves indicated. Size and type as shown on Drawing. Control system will work in conjunction with a central control system.

B. Control Enclosures: Weatherproof enclosure with locking cover and 2 matching keys. Enclosure construction complies with NFPA 70 and NEMA 250, Type 4, and includes provision for grounding. All control wires that are above ground shall be installed in conduit. Electrical wiring shall be installed according to local code. Provide surge protectors in all controllers.

1. AG 240 V Surge Arrester: Install in approved J-box next to controller. Install per manufacturer recommendations.

C. Transformer: Internal-type, and suitable for converting 120 volts a.c. building power to 24 volts a.c. power.

D. Controller Stations for Automatic Control Valves: Each station is variable from approximately 1 to 60 minutes. Include switch for manual or automatic operation of each station.

E. Timing Device: Adjustable, 24-hour, 14-day clock to operate any time of day. Include provision for the following settings:

1. Setting to skip operation any day in timer period.
2. Setting for operation every other day.
3. Settings for operation 2 or more times daily.
4. Include manual or semi-automatic operation without disturbing preset automatic operation.
5. Provide NI-CAD battery and trickle charger to automatically power the timing device during power outages.

F. Surge Protection: As required per manufacturer’s recommendations. Install at all required grounding per manufacturer’s recommendations along two-wire path.

G. Wiring:
1. Two-wire control wire shall be Paige, UF-UL listed, color coded, tin coated copper conductor, direct burial, 14 AWG, 2 conductor, irrigation control cable with PVC insulation and impregnated polyethylene jacket.
2. Run (2) 2-conductor cables to every valve decoder, sensor, and master valve.
3. Provide 36-inch coil in each valve box and 18-inch loop at each direction change in
4. trench. Do not loop two-wire path, path shall be installed in star pattern.
5. Waterproof Wire Connectors: DBY/DBR-600 splice kit by 3M or approved equal by Architect before installation.
6. Surge Protector: Per manufacturers standard drawings and specification.

2.8 VALVE BOXES

A. Carson Industries or approved equal with locking lid. Valve box size per drawings. 12” round box for all mainline ball valves, gate valves, and hose bibs. All boxes shall have green lids labeled “Irrigation” in English and Spanish.

2.9 IRRIGATION SYSTEM ACCESSORIES

A. Valve ID Tags:

1. Christy's: Stamped ID tag: 2 -1/4" x 2-3/4" yellow plastic tag with alpha-numeric labeling matching zone number on drawings.

B. Valve Box Supports:
1. Standard clay paving bricks without holes (8-inch x 4-inch x 2-inch).

C. Non-Woven Geotextile Fabric:
1. DeWitt 4.1 oz, 20-year woven polypropylene weed barrier or approved equal.

D. Detectable Marking Tape:
1. Christy's 4.5 MIL detectable marking tape, 3-inch width. Shall be purple and reads "IRRIGATION".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to beginning work, the contractor shall conduct a site and installation overview with the Twin Falls Parks and Recreation Department and College of Southern Idaho.

B. Investigate and determine available water supply water pressure and flow characteristics. Notify landscape architect if they differ from listed on the drawings.

C. Ensure that pump station is providing necessary performance. Notify Landscape Architect of any deviations from design performance.

3.2 INSTALLATION GENERAL

A. Comply with manufacturer's written installation instructions. Complete field assembly of components where required.

B. Storage of Materials: Store all materials in a secured location. Do not allow materials to be exposed to environmental conditions that are harmful to the material, i.e. sun and windblown dust. Cover materials to protect where required.

C. Install piping in sleeves where crossing sidewalks, roadways, parking lots, playgrounds and railroads.
2. Install piping sleeves by boring or jacking under existing paving, where possible.
3. If it is necessary to cut pavement sections, pavement shall be replaced in cut areas per ISPWC standards and requirements.

3.3 PIPING APPLICATIONS

A. Refer to Part 2 of this Section for detailed specifications for pipe and fittings products listed below. Use pipe, tube, fittings, and joining methods according to the following applications. Piping in pits and aboveground may be joined with flanges instead of joints indicated.

B. Use pipe, tube, fittings, and joining methods according to the following applications.

C. Pressure Piping Underground: Use the following:

1. 3- Inches and Larger: Class 200 PVC with Ductile Iron Joint Restraint fittings

2. 2 ½- Inches (DN 80) and Smaller: ASTM D 2241, SDR 26, Schedule 40, polyvinyl chloride (PVC) plastic pipe; ASTM D 2467, Schedule 40, PVC plastic, socket-type pipe fittings; and solvent-cemented joints.

D. Circuit Piping: Use the following:

1. 2 ½- Inches (DN 80) and Smaller: ASTM D 2241, SDR 26, Schedule 40, polyvinyl chloride (PVC) plastic pipe; ASTM D 2467, Schedule 40, PVC plastic, socket-type pipe fittings; and solvent-cemented joints.

E. Sleeves: ASTM D 2241, SDR 21 Class 200, polyvinyl chloride (PVC) plastic pipe; ASTM D 2466, Schedule 40, PVC plastic, socket-type fittings; and solvent-cemented joints. Sleeve diameter shall be two sizes larger than pipe installed in sleeve with minimum sleeve size being 4”. Extend sleeves 18” beyond walk or pavement edge.

3.4 JOINT CONSTRUCTION

A. Threaded Joints: Thread pipes with tapered pipe threads according to ASME B1.20.1, apply tape or joint compound, and apply wrench to valve ends into which pipes are being threaded.

B. Polyvinyl Chloride (PVC) Piping Solvent-Cemented Joints: Construct joints according to ASTM D 2672 and ASTM D 2855.
1. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling when joining plastic pipe and fittings with solvent cements.

C. Dissimilar Materials Piping Joints: Construct joints using adapters that are compatible with both piping materials, outside diameters, and system working pressure. Refer to "Piping Systems - Common Requirements" Article for joining dissimilar metal piping.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, and in other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

B. Install components having pressure rating equal to or greater than system operating pressure.

C. Install piping free of sags and bends. Deflections angles shall not exceed manufacturer’s recommendations.

D. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

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

F. Piping Connections: Except as otherwise indicated make piping connections as specified below.
1. Install unions, in piping 2 inches (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having 2-inch (DN 50) or smaller threaded pipe connection.
2. Install dielectric fittings to connect piping of dissimilar metals.

3.6 PIPING INSTALLATION

A. Install underground polyvinyl chloride (PVC) plastic pipe according to ASTM D 2774.

B. Lay piping on solid subbase, uniformly sloped without humps or depressions.
1. Install polyvinyl chloride (PVC) plastic pipe in dry weather when temperature is above 40 deg F (4 deg C). Allow joints to cure at least 24 hours at temperature above 40 deg F (4 deg C) before testing, unless otherwise recommended by manufacturer.

C. Minimum Cover: Provide following minimum cover over top of buried piping:
1. Pressure Piping: Per Drawings.
2. Circuit Piping: Per Drawings.
3. Sleeves: Per Drawings.

D. Boring
1. Locations: Boring shall be used to route pipe, wiring or both under concrete structures such as walks or curbs where trenching is impractical. Sleeves shall be installed in all bored holes.
2. Method: Boring shall be accomplished with a drill, auger, water jet, or any other instrument approved by the Owner's Representative capable of producing a precise hole. Boring shall not disturb overlaying structures or cause settlement and damage to those structures. Repair or replace any pavement damaged during boring procedures.

E. Install piping under sidewalks and paving in sleeves.

F. Back-filling
1. Inspection: The trenching shall not be backfilled until inspection and pressure testing has been completed and the pipe installation, including the grade, alignment and jointing has been found to be in compliance with the requirements of the plans and specifications.

2. Around and Over Pipe:

a. Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than 1/2 inch shall be used in backfilling around and over the installed pipe.

b. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The Contractor may at his option and own expense provide an acceptable imported material.

c. Backfill material shall be carefully deposited around and over the pipe in layers not more than 6 inches thick, loose measurement, wetted to optimum moisture content and uniformly compacted to at least 95 percent of the maximum density obtainable at optimum moisture content as determined by AASHTO T99 Method A or D (latest revision), until the pipe has a cover depth of at least 12 inches.

3. Remainder of Trench Backfill:

a. The remaining depth of the trench shall be backfilled to existing finish grade, with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.

b. Contractor shall be required to repair any settling problems which occur in the trench locations for the duration of the warranty period.

G. Pipe fittings
1. All piping less than 3" diameter shall use Schedule 40 socket type fittings.

3.7 VALVE APPLICATIONS

A. Drawings indicate valve types to be used.

3.8 VALVE INSTALLATION

A. Valves: Install underground valves in valve boxes as shown on Drawings.

B. Control Valves: Install in valve control valve boxes, arranged for easy adjustment and removal. Install union on downstream side. Maximum (1) valve per valve box.

C. Place 6 inches minimum of gravel below control valves for drainage. Maintain 4 inches minimum between bottom of valves and top of gravel. Place filter fabric barrier between gravel and valves. Valve box shall be free of dirt and debris.

3.9 DRIP IRRIGATION INSTALLATION

A. Drip line: To be installed per Drawings.
1. Install drip to ensure an optimum and equal amount of water is applied to ensure the health of all plant material.
2. All tubing shall be staked down with soil staples at five foot interval maximum.
3. Landscape mulch shall not be placed until inspection and approval of landscape architect.

3.10 AUTOMATIC CONTROL SYSTEM INSTALLATION

A. Install controllers and controller enclosure according to manufacturer's written instructions and as indicated.

B. Install control wiring in same trench with piping. Where wiring leaves from piping trenches, install wiring in conduits at 18-inch depth minimum.

C. Install control wiring in accordance with Specifications.

D. Install decoders per manufacturer’s written instructions. Route control wire from decoder to valve through conduit as shown on drawings.

E. Install all exposed wiring in rigid conduit as shown on the drawings.

3.11 TRENCHING

A. Trench Size:
1. Minimum Width: 4 inch pipe and larger – 12 inches.
2. Minimum Width: 3 inch pipe and smaller – 9 inches.

B. Trench to accommodate grade changes and slope to drains.

C. Maintain trenches free of debris, material, or obstructions that may damage pipe.

3.12 IRRIGATION SYSTEM ACCESSORIES
1. Standard yellow I.D. tags submit product for approval prior to ordering.
2. Detectable Warning Tape shall be installed at mainline only and as noted on drawings.

3.13 CONNECTIONS

A. Connect piping to devices, valves, control valves, specialties, and accessories.

B. Connect water supplies to irrigation systems. Include reduced pressure back-flow preventers on potable water supplies.

C. Electrical Connections: Connect to power source, controllers, and automatic control valves.

3.14 FIELD QUALITY CONTROL

A. Testing: Perform test of piping and valves before back-filling trenches. Piping may be tested in sections to expedite work. Owners representative must be present for testing.
1. Make all necessary provisions for thoroughly bleeding the line of air and debris.
2. Before testing, fill the line with water for a period of at least 24 hours.
3. After valves have been installed, test all live water lines for leaks at a pressure of 100 psi for a period of two hours, with all couplings exposed and with all pipe sections center-loaded.
4. Furnish all necessary testing equipment and personnel.
5. Correct all leaks and retest until acceptance by the Project Landscape Architect.

B. Field inspection and testing will be performed under provisions of Division 1.

C. Installer’s Field Service
1. Prepare and start systems under provisions of Division 1.
2. Provide one complete spring start-up and a fall shutdown, including winterization to blow out entire system with compressed air.

D. Adjust work under provisions of Division 1.

E. Change and/or adjust head types for full water coverage as directed.

3.15 CLEANING AND ADJUSTING

A. Flush dirt and debris from piping before installing sprinklers and other devices.

B. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.

C. Adjust settings of controllers and automatic control valves to insure proper watering of all landscaping.

3.16 COMMISSIONING

A. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturers, proceed as follows:
1. Verify that specialty valves and their accessories have been installed correctly and operate correctly.
2. Verify that specified tests of piping are complete.
3. Check that all devices are correct type.
4. Energize circuits to electrical equipment and devices.
5. Adjust operating controls.

B. Operational Testing: Perform operational testing after hydrostatic testing is completed, backfill is in place, and irrigation is adjusted to final position.

3.17 DEMONSTRATION

A. Provide irrigation system demonstration under provisions of Division 1.

B. Demonstrate to Owner: that system meets coverage requirements and that automatic control functions properly. Train Owner on Baseline BaseManager software.

C. Demonstrate to Owner's maintenance personnel operation of equipment, drip line and components, specialties, and accessories. Review operating and maintenance information including start up and winterization procedures.

D. Provide 7 days written notice in advance of demonstration.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tree and shrub planting pits.
2. New trees and shrubs and accessories.
3. Soil amendments and fertilizer.
4. Landscape rock mulch and landscape boulders.
5. Tree and shrub establishment.
6. Tree and shrub maintenance.

B. Definitions:

1. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, Brome Grass, Black Henbane, Buffalobur, Common Crupina, Dalmatian Toadflax, Diffuse Knapweed, Dyer's Woad, Eurasian Watermilfoil, Field Bindweed, Hoary Cress, Joined Goatgrass, Leafy Spurge, Matgrass, Meadow Hawkweed, Meadow Knapweed, Milium, Musk Thistle, Orange Hawkweed, Perennial Pepperweed, Perennial Sowthistle, Poison Hemlock, Puncturevine, Purple Loosestrife, Russian Knapweed, Scotch Broom, Scotch Thistle, Silverleaf Nightshade, Skeletonleaf Bursage, Spotted Knapweed, Syrian Beancaper, Toothed Spurge, Yellow Starthistle, Yellow Toadflax.
2. Plants: Living trees, plants, and ground cover as specified in this Section and indicated on Drawings, and described in ANSI Z60.1.

1.2 REFERENCES

A. ANSI Z60.1 - Nursery Stock.

B. NAA (National Arborist Association) - Pruning Standards for Shade Trees.

C. FSO-F-241 - Fertilizers, Mixed, Commercial.

1.3 SUBMITTALS

A. Provide submittals per Division 01 Specifications.

B. Submit list of plant life sources and confirmed availability.

C. Landscape Rock Mulch:

1. Black and Tan Crushed Basalt Rock Mulch: Size per plans. Submit 5-gallon bucket with sample name and product material for each type and size of mulch.

2. Round River Rock: Size per plans. Submit 5-gallon bucket with sample name and product material for each type and size of mulch and Representative photographs of mulch at source.

D. Landscape Boulders: Representative photographs of boulders at source. Provide tape measurement of boulders ensuring compliance with dimensions as indicated on plans.

E. Product Data: Provide Manufacturer’s (catalog) product information.

1. Tree Stakes.

2. Tree Ties.

3. Soil Amendments and Fertilizer.

4. Maintenance Fertilizer.

5. Pre-emergent herbicide.

F. Tree and Shrub Establishment Irrigation Schedule.

G. Tree and Shrub Maintenance Irrigation Schedule.

1.4 QUALITY ASSURANCE

A. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years' experience.

B. Installer Qualifications: Company specializing in installing and planting the plants with three years' experience.

C. Maintenance Services: Performed by Installer.

D. Regulatory Requirements:

1. Comply with regulatory agencies for fertilizer and herbicide composition.

2. Plant Materials: Certified by state department of agriculture; Described by ANSI Z60.1; free of disease or hazardous insects.

E. Quality:

1. Plants shall be 100 percent sound, healthy, vigorous, and free from plant disease, insect pests or their eggs, noxious weeds, and have healthy, normal root systems. Container stock shall be well established and free of excessive root-bound conditions.

2. Do not prune plants or top trees prior to delivery.

3. Plant materials shall be subject to approval by Architect as to size, health, quality and character. Architect reserves the right to inspect trees and shrubs either at place of growth or at site for compliance with requirements.

4. Bare root trees are not acceptable.

F. Measurements:

1. Measure height and spread of specimen plant materials with branches in their normal position as indicated on Drawings or Plant List.
2. Measure caliper of trees 6 inches above surface of ground.
3. Where caliper or other dimensions of plant materials are omitted from Plant List, plant materials shall be normal stock for type listed.
4. Plant materials larger than those specified may be supplied with approval of Architect
   a. If complying in all other respects.
   b. If at no additional cost to Owner.
   c. If sizes of roots or balls are increased proportionately.
5. Shape and Form - Plant materials shall be symmetrical or typical for variety and species and conform to measurements specified in Plant List.
6. Provide plant materials from a licensed nursery.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

C. Protect and maintain plant life until planted.

D. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.6 PROJECT/SITE CONDITIONS

A. Do not install plant life when ambient temperatures may drop below 40 deg F or rise above 90 deg F.

B. Do not install plant life when wind velocity exceeds 20 mph.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate work under provisions of Division 01 Specifications.

B. Install plant life after and coordinate with installation of underground irrigation system piping and watering heads specified in Section 32 84 00.

C. Coordinate plant installation work with irrigation work specified and in the Drawings.

1.8 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MATERIALS

A. Substitutions or equivalent products shall be in accordance with Division 01 Specifications.

B. Topsoil: Material per Specifications Section 31 20 00.

1. Depth and volume as required for tree pits as noted in this section and on the Drawings. Provide necessary volume to ensure planter areas are filled to specified finish grade.

2. All non turf planter bed areas shall have a minimum of 18” of topsoil.

C. Trees, Shrubs, Plants and Ground Cover: Species and size identifiable in plant schedule on the Drawings, grown in climatic conditions similar to those in locality of the Work.

D. Soil Amendment Materials:

1. Granular Soil Conditioner: Turface MVP calcined, non-swelling illite and silica clay, or approved equal.

a. Submit product data and sample for approval prior to ordering.

b. PROFILE Products, LLC, 800.207.6457 or www.turface.com

2. Fertilizer:

a. Commercial Grade Compost:
1) Compost shall be measured by the cubic yard at the point of loading.
2) Compost shall be a well decomposed, stable, weedfree organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings or source-separated or mixed solid waste. The product shall contain no substances toxic to plants, will possess no objectionable odors and shall not resemble the raw material from which it was derived.
3) Compost shall meet the following parameters:
a) pH - Acceptable Range: 6.0 - 8.4 (1:5 by weight).
b) Soluble Salts - Acceptable Range: 0-7 mmhos/cm (1:5 by weight).
c) Maturity Indicators:
Ammonia N / Nitrate N Ratio - < 4.
Carbon to Nitrogen Ration < 12.
d) Particle size: 98 percent pass through 1/2-inch screen.
e) Physical contaminants (inert matter): less than 1 percent
f) Submit lab testing indicating compliance with the parameters above. Lab testing shall also provide the following information: Bulk Density; percent Inorganics; percent Moisture; Particle Size Distribution, Primary and Secondary Nutrients; Trace Elements; Organic Matter Expressed in Percentage and Pounds per CY.

b. Humic Acid: Live Earth Humate Soil Conditioner.

c. Planting Tablet Fertilizer: 21 gram - Agriform.

3. Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of plants.

E. Maintenance Fertilizer: Live Earth Tree and Shrub 5-10-10.

F. Pre-Emergent Herbicide: Tupersan Herbicide Wettable Powder, Tenacity, or approved equal.

G. Weed Control Herbicide:

1. Selective Broadleaf Weed Control: 2,4-D Amine Weed Killer.
2. Broad Spectrum Herbicide: Roundup Pro.

2.2 ACCESSORIES

A. Stakes: As noted on the Drawings.

B. Tree Ties: Durable rubber ties designed for staking of trees. Length as required per manufacturer's specifications. Submit manufacturer's catalog cut sheet for approval prior to ordering.

C. Landscape Rock Mulch:

1. 3-inch minimum depth of 1-inch crushed basalt. Mulch shall be free of fines and rock less than ¾-inch in size. Submit sample for approval prior to installation. Color: Black and Dark Tan.
2. 12-inch minimum depth of 3-inch to 8-inch round river rock. Rock shall be free of fines and rock less than 3-inch in size. Submit sample for approval prior to installation. Color: Tan, Grey.
3. 12-inch minimum depth of 6-inch round cobblestone rip rap. Rock shall be free of fines and rock less than 6-inch in size. Submit sample for approval prior to installation. Color: Tan, Grey.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that prepared topsoil is ready to receive work.

B. Verify that required underground utilities are available, in proper location, and ready for use.

C. All planters shall be completely filled with topsoil to within 3-inch / 12-inch of adjacent curb, walk, etc. Topsoil elevation shall be adjusted per landscape mulch type, see Drawings.

3.2 SOIL PREPERATION

A. Prior to placement of plants, topsoil shall be water settled through application of .5-inch of precipitation through the irrigation system. Coordinate with Section 32 84 00. All areas of settlement shall be top dressed with approved topsoil material to provide a smooth, even surface. Any settlement of soils after placement of plants shall be corrected by the Contractor at no cost to the Owner.

B. Tree Pit Backfill Planting Mix: Blend topsoil and soil amendments and fertilizer for tree pit backfill at the following rates. Blend amendments thoroughly with soil backfill. Coordinate with Drawings for size of planting pit. Blend topsoil and amendments with native soil at bottom and edge of pit.

1. Tree Pits shall be: 5 feet by 5 feet by 1.5 feet.
2. Application Rates:
   a. Granular Soil conditioner: 50 lbs per Tree Pit.
   b. Humic Acid: 10 lbs per Tree Pit.

c. Commercial grade compost - 5 cubic feet per Tree Pit.

d. Planting Tablet Fertilizer - 4 tablets per Tree Pit.

C. Shrub Pit Backfill Planting Mix: Blend topsoil and soil amendments and fertilizer for shrub pit backfill at the following rates. Blend amendments thoroughly with soil backfill. Coordinate with Drawings for size of planting pit. Blend topsoil and amendments with native soil at bottom and edge of pit.

1. Shrub Pits shall be: 2.5 feet by 2.5 feet by 1 foot.

2. Application Rates:

a. Granular Soil conditioner: 10 lbs per Shrub Pit.

b. Humic Acid: 2 lbs per Shrub Pit.

c. Commercial grade compost - 1 cubic foot per Shrub Pit.

d. Planting Tablet Fertilizer - 2 tablets per Shrub Pit.

D. Placement and blending of soil amendments listed in this section shall be photo documented by the contractor. Document installation of all soil amendment application and blending and provide to the Landscape Architect for review and approval. Contractor shall provide product receipts for all products specified in this section for review and approval by the Landscape Architect. Product receipts shall list date of delivery, delivery address and location, project name, quantity delivered and product delivered.

E. Representative plant material must be delivered to the site for review and approval by the Landscape Architect prior to installation. Any plant material placed without prior approval is subject to removal at no cost to the Owner.

3.3 EXECUTION

A. Place boulders for best appearance for review and final orientation by Landscape Architect. Coordinate with Drawings for placement depth into soil. Coordinate with installation of irrigation system and plant material.

B. Place plants for best appearance for review and final orientation by Landscape Architect.

C. Set plants vertical.

D. After placement cut all string, wires, etc. and remove string, wire and burlap from top and sides of root ball before backfilling.

E. Set plants in pits or beds, partly filled with prepared plant soil mix. Backfill soil mixture in 6 inch layers. Maintain plant materials in vertical position. Add fertilizer tablets in plant pit (at 2/3 full) as per manufacturer's recommendations.

F. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

G. Installation of Accessories:

1. Apply pre-emergent herbicide to planting areas after completion of planting. Planting areas shall be free of existing weed growth prior to application of herbicide. Apply herbicide in accordance with Manufacturer's recommendations.

2. Place Landscape Rock Mulch and Round River Rock over landscape planting bed areas. See Drawings for location and depth. Keep rock mulch and round river rock; 6-inch from base of trees and shrubs.

3.4 TREE AND SHRUB ESTABLISHMENT

A. General: Starting immediately after tree and shrub placement, establishment will begin and continue through the grow-in period. Irrigation and weed control shall be the responsibility of the Contractor as defined herein. Protect planter areas with signs to prevent traffic throughout the establishment period.

B. The establishment period shall have a duration of thirty (30) days.

C. Irrigation:

1. Contractor shall submit for approval a proposed "Tree and Shrub Establishment Irrigation Schedule." This schedule shall include Zone designation, days per week, cycles per day and cycle run time. Include targeted daily and weekly precipitation rates for each zone based on current climatic conditions.
2. Water shall be applied to moisten the root ball and the soil adjacent to the root ball. Avoid overwatering and creating areas of standing water.
3. Irrigation shall be monitored daily to identify areas receiving too much or too little precipitation.

D. Weed Control:

1. Control growth of weeds throughout establishment period. Hand pull weeds weekly.
2. Chemical herbicide shall not be used in shrub areas during the establishment period.

E. Upon completion of the establishment period the maintenance period shall begin.

3.5 TREE AND SHRUB MAINTENANCE

A. Maintenance shall be according to the following standards. All areas shall be weeded and cultivated at intervals of not more than seven (7) days. Watering, trash and debris removal, fertilization, spraying and pest control, as required, shall be included in the maintenance period. Cleaning of street gutters and sidewalks shall be included. The Contractor shall be responsible for maintaining adequate protection of the area. Damaged areas shall be repaired at the Contractor’s expense.

B. The maintenance period shall have a minimum duration of sixty (60) days and continue until the date of Substantial Completion.

C. Irrigation:

1. Contractor shall submit for approval a proposed "Tree and Shrub Maintenance Irrigation Schedule." This schedule shall include Zone designation, days per week, cycles per day and cycle run time. Include targeted daily and weekly precipitation rates for each zone based on current, seasonal climatic conditions.
2. Water shall be applied to moisten the soil appropriately for the current, seasonal climatic conditions. Avoid overwatering and creating areas of standing water.
3. Irrigation shall be monitored weekly to identify areas receiving too much or too little precipitation.
4. Trees in Turf Areas: If sod/seed irrigation is not adequate to provide for trees, hand watering shall occur to moisten the root ball and soil adjacent to the root ball.

D. Weed Control:

1. Control growth of weeds throughout maintenance period. Inspect turf areas every seven (7) days for weed growth.
2. Utilize weed killer and hand pulling to control weeds in all planter and turf areas.

E. Fertilization:

1. One application of Maintenance Fertilizer shall be applied during the maintenance period. Application shall occur approximately sixty (60) days after installation of plant material and prior to the date of Substantial Completion.
2. Maintenance fertilizer shall be applied at the following rate per manufacturer's written instructions for root feeding:
    a. Dilute 40:1 with water prior to use.
    b. Trees: Apply 5 gallons of diluted product per inch of trunk diameter.
    c. Shrubs: Apply 3 gallons of diluted product per shrub.
3. Apply Liquid Humic Acid / water mixture to root ball and area directly adjacent to root ball.

F. Insect and Disease Control: Maintain a reasonable level of control with approved materials.

G. Plant material replacement: Replace dead, dying and missing plants with plants of a size, condition and variety to match plans and as acceptable to the Architect at Contractor's expense under the provisions Division 01 Specifications.

H. Continuously maintain the entire project area during the progress of work until the date of Substantial Completion.

3.6 FIELD QUALITY CONTROL

A. Perform field inspections under provisions of Division 01 Specifications.

B. Coordinate field inspections with Specification Section 32 84 00.

C. Contractor Performed Inspections: The contractor shall perform the following inspections and provide written confirmation of completed and successful installation to the Architect.

1. Tree Pit Backfill Planting Mix and Tree Placement: Provide required photographs and product receipts demonstrating successful placement and blending of specified soil amendments including the placement of trees and the backfill of the tree planting pit.
2. Shrub Pit Backfill Planting Mix and Shrub Placement: Provide required photographs and product receipts demonstrating successful placement and blending of specified soil amendments including the placement of shrubs and the backfill of the shrub planting pit.
3. Tree and Shrub Maintenance - Fertilization: Provide required photographs and product receipts demonstrating successful placement of specified maintenance fertilizer.

D. Landscape Architect Performed Inspections:

1. Trees and Shrubs - Material and Installation: The Contractor shall schedule one site visit with the Landscape Architect to inspect representative plant material and the installation of trees and shrubs.

3.7 CLEANING

A. After all planting, establishment and maintenance operations have been completed; remove all trash, excess soil or rubbish from the property. All scars, ruts or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. Contractor shall pick up all trash resulting from this work no less frequently than each day before leaving the site. All trash shall be removed completely from the site. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition acceptable to the Architect and Construction Manager.

3.8 PROTECTION

A. Protect planter areas with warning signs until date of Substantial Completion.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Water distribution piping and related components outside the building for water service, fire service and irrigation service.
2. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 RELATED SECTIONS

A. Division 01 Sections.

B. Division 31 Section "Earth Moving" utility trench excavation, bedding and backfill.

C. Idaho Standards for Public Works Construction, Current Edition.

1.3 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data: for each type of product indicated.

C. Shop Drawings

1. Indicate general installation, components, dimensions, coverage, clearances, and methods of installation.

D. Field Reports: Field quality-control test reports, pressure test reports and disinfection reports.

E. Operations & Maintenance Data: Submit manufacturer’s written Operations & Maintenance data for all components & accessories.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
2. Comply with AHJ Standards for potable-water-service piping, including materials, installation, testing and disinfection.
3. Piping materials shall bear label, stamp, or other markings of the specified testing agency.
4. Comply with ASTM F 645 for selection, design and installation of thermoplastic water piping.
5. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

6. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
7. Comply with local plumbing codes.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01.

1.6 COORDINATION

A. Coordinate connection to water main with utility company.

1.7 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Substitutions or equivalent products shall be in accordance with Division 01 Specifications.

2.2 PIPES AND PIPE FITTINGS

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

2.3 PIPING SPECIALTIES

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

2.4 GATE VALVES

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

2.6 WATER METERS & METER BOXES/VAULTS

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

2.7 FIRE HYDRANTS

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

B. Color: Red.

2.8 FIRE DEPARTMENT CONNECIONS

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

2.9 TRENCH FILL MATERIALS

A. Bedding: per specification section 312000.

B. Trench backfill: per specification section 312000.

2.10 ACCESSORIES

A. Thrust Blocks: Per the Drawings and ISPWC.

B. Anchorages: Provide anchorages for tees wyes, crosses, plugs, caps, bends, valves, and hydrants. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages.

1. Rods: Steel, ASTM A 575.
2. Rod Couplings: Malleable-iron, ASTM A 197.
3. Thrust Blocks: Concrete, 2,500 psi.

C. No.12 Direct Burial Locator wire with Dri-splice connectors shall be installed with waterlines. Wire shall extend to surface at all valve boxes/meters and be fastened to the top of the pipe at maximum 10' intervals.

D. Warning Tape: Install per specification section 312000.

PART 3 - EXECUTION

3.1 EXECUTION

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

B. Route pipe in straight lines.

C. Install pipe to allow for expansion and contraction without stressing pipe or joints.

D. Install access fitting to permit disinfection of water system.

E. Form and place concrete for thrust blocks at each change of direction of pipe main.

F. Establish elevations of buried piping to ensure not less than 4'-0" of cover and not more than 5’-0” unless otherwise approved in writing by the AHJ.

G. Set valves on solid bearing. Locate valve a minimum of 12" away from hydrant.

H. Center and plumb valve box over valve. Set box cover flush with finished grade.

3.2 DISINFECTION AND TESTING

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sanitary sewerage piping, fittings and accessories.

1.2 RELATED SECTIONS

A. Division 01 Sections.

B. Division 31 Section "Earth Moving" utility trench excavation, bedding and backfill.

C. Idaho Standards for Public Works Construction, Current Edition.

1.3 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data: Provide data indicating pipe, manholes, fittings, accessories, and fill material.

C. Project Record Documents

1. Submit documents under provisions of Division 01.
2. Conform to requirements of ISPWC.
3. Record location of pipe runs, connections, cleanouts and invert elevations.
4. Identify and describe unexpected variations to subsoil conditions or discovery of unchartered utilities.

D. Field Reports: Field quality-control and testing reports.

E. Operations & Maintenance Data: Submit manufacturer’s written Operations & Maintenance data for all components & accessories.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements

1. Conform to requirements of ISPWC.

B. Utility trench compaction

1. Per Division 31 Earth Moving.

1.5 PROJECT/SITE CONDITIONS

A. Verify that field measurements and elevations are as indicated.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate work under provisions of Division 01.

B. Coordinate the Work with termination of sanitary sewer connection outside building, and trenching.

1.7 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Substitutions or equivalent products shall be in accordance with Division 01 Specifications.

2.2 MATERIALS

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

2.3 COMPONENTS

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

2.4 ACCESSORIES

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that trench cut 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 structural fill.

B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 EXECUTION

A. Per the Drawings, AHJ Supplemental Specifications to the ISPWC, and the ISPWC.

B. Bedding

1. Excavate pipe trench in accordance with Section 312000 for work of this Section.
2. Place bedding material in accordance with Section 312000 at trench bottom, level materials in continuous layer not exceeding 4 inches compacted depth.
3. Maintain optimum moisture content of bedding material to attain required compaction density.

C. Pipe

1. Install pipe, fittings, and accessories in accordance with ASTM D 2321, manufacturer's instructions. Seal joints watertight.
2. Pipe installation and backfill shall be consistent with the drawings and the ISPWC.
3. Lay pipe to slope at gradients noted on drawings; with maximum variation from true slope of 1/16 inch in 10 feet.
4. Install bedding to minimum compacted thickness of 6” above pipe, 4” below pipe and 12” at sides of pipe.
5. Refer to Section 312000 for trenching and detectable warning tape requirements. Do not displace or damage pipe when compacting.
6. Connect to building sanitary sewer outlet and collection system.

3.4 TESTING

A. Prior to final acceptance, after all utilities are in and prior to paving, the following testing shall perform testing in the presence of the Engineer.

B. Visual Inspection.

1. Per AHJ and ISPWC.

C. Air Pressure Testing.

1. Per AHJ and ISPWC.

D. Pipe Cleaning.

1. Per AHJ and ISPWC.

E. Deflection Tests for Flexible Pipe.

1. Per AHJ and ISPWC.

F. Closed Circuit Television (CCTV) Inspection.

1. Per AHJ and ISPWC.
2. Test all mains and service lines.

3.5 PROTECTION

A. Protect finished installation under provisions of Division 01.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Storm drainage piping, fittings, and accessories.
2. Catch basins, manholes, clean-outs, grates and frames.

1.2 SUBMITTALS

A. Submit under provisions of Division 01

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

C. Shop Drawings:

1. Catch basins: Include plans, elevations, section, details, frames, covers and grates.

D. Field quality-control reports.

E. Project Record Documents

1. Submit documents under provisions of Division 01.
2. Accurately record location of pipe runs, connections, catch basins, cleanouts, and invert elevations each day.
3. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities each day.

F. Operations & Maintenance Data: Submit manufacturer's written Operations & Maintenance data for all components & accessories.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Conform to requirements of agency having jurisdiction.
2. Piping materials shall bear label, stamp, or other markings of the specified testing agency.

B. Comply with ASTM D 2321 and installation of thermoplastic drainage piping.

1.4 WARRANTY

A. Contractor shall warrant work as provided by the General and Supplementary Conditions and Division 01 Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Substitutions or equivalent products shall be in accordance with Division 01 Specifications.

2.2 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.

1. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.3 PVC PIPE AND FITTINGS

A. PVC Drain Piping:

1. Pipe: ASTM D 3034, SDR 35, PVC drainage pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

2.4 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: ASTM C 443, rubber.
2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Shielded, Flexible Couplings:

1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.5 CLEANOUTS

A. Per drawings and details.

2.6 CATCH BASINS

A. Per drawings and details.

2.7 ACCESSORIES

A. Warning Tape: Install per specification section 312000.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

D. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

E. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install PE corrugated sewer piping according to ASTM D 2321.
3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

3.3 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Install piping so cleanouts open in direction of flow in drainage pipe.

1. Construct cleanout as specified on drawings.

3.4 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CONNECTIONS

A. Connect non-pressure, gravity-flow drainage piping to building storm drains.

3.7 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
    f. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
    g. Re-inspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
6. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    a. Option: Test plastic piping according to ASTM F 1417.
    b. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

E. Refer to Division 31 Section "Earth Moving" for trenching compaction.

3.9 CLEANING

A. Clear interior of piping and structures of dirt and other superfluous material as work progresses.

B. Flush piping to remove collected debris. Remove collected debris from all manholes and catch basins. Debris shall not enter infiltration facilities.

C. Place plugs in ends of uncompleted pipe at end of day or whenever work stops.

D. After substantial completion, remove temporary filter fabric from catch basin frames.

3.10 PROTECTION

A. Protect finished installation under provisions of Division 01.

END OF SECTION